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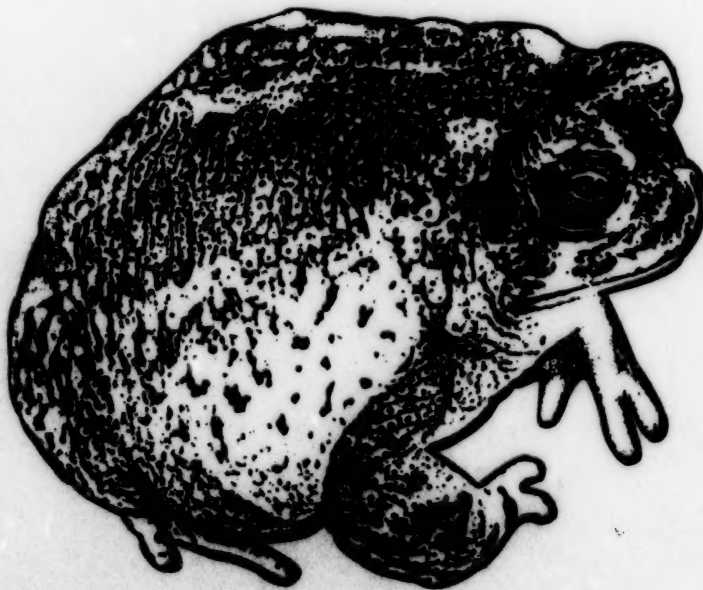
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U.S. Fish and Wildlife Service

Draft Recovery Plan

For the Arroyo Southwestern Toad



98-022741

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DRAFT RECOVERY PLAN

for the

ARROYO SOUTHWESTERN TOAD
(Bufo microscaphus californicus)

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Regional Director, U.S. Fish and Wildlife Service

Date: _____

DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and protect listed species. Plans are published by the U.S. Fish and Wildlife Service, and sometimes are prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 1998. Draft Recovery Plan for the Arroyo Southwestern Toad (*Bufo microscaphus californicus*). U.S. Fish and Wildlife Service, Portland, Oregon. v+71pp.

EXECUTIVE SUMMARY

Current Status: The arroyo southwestern toad (*Bufo microscaphus californicus*) is listed as endangered. It is known from 22 drainages in the coastal and desert areas of nine counties along the southern coast of California. The range extends into northwestern Baja California.

Habitat Requirements and Limiting Factors: The arroyo southwestern toad (arroyo toad) is endemic to primarily the coastal plain and mountains of central and southern California and northwestern Baja California. These toads breed in stream channels and use stream terraces and surrounding uplands for foraging and wintering. Direct habitat loss due to urbanization, agriculture, and dam construction is the main cause for the decline of arroyo toads. Other threats include water diversions, road building, livestock grazing, mining, recreational activities, loss of habitat due to exotic plants, and predation by introduced species. Although the species evolved and has survived in an environment periodically impacted by fire, flood, and drought, the interactions of natural events with human alterations of the habitat may lead to the extirpation of local populations.

Recovery Priority: 9 (Subspecies, moderate degree of threat, high recovery potential).

Recovery Objective: Delist.

Recovery Criteria: The arroyo toad will be considered for reclassification from endangered to threatened status when management plans have been approved and implemented on federally managed lands to provide for conserving, maintaining and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat; and when these measures are successful in maintaining a minimum of 19 self-sustaining populations of arroyo toads (minimum number of populations for each agency and locale are indicated in parentheses), including Fort Hunter Liggett Army Reserve Training Center (1), Camp Joseph H. Pendleton Marine Corps Base (2), Los Padres National Forest (4), Angeles National Forest (3), San Bernardino National Forest (1), Cleveland

National Forest (7) and the Jacomba (In-Ko-Pah Mountains) Wilderness Study Area (1) managed by the Bureau of Land Management. Self-sustaining populations are those documented as having successful recruitment in 7 of 10 years of average to above average rainfall amounts with normal rainfall patterns.

Delisting of the arroyo toad will be considered when the genetic and phenotypic variation of the arroyo toad throughout its range in California is secured by maintaining 15 additional self-sustaining populations of arroyo toads on coastal plain, coastal slope, desert slope, and desert lands, including known populations outside of Federal jurisdiction on the Whitewater River, Riverside County; in the San Juan Creek basin, Orange County; Santa Margarita River basin, San Diego and Riverside Counties; and the San Luis Rey River, San Dieguito River/Santa Ysabel Creek, San Diego River, Sweetwater River, Otay River/Dulzura Creek, and Tijuana River basins in San Diego County.

Actions Needed:

- 1) Stabilize and maintain populations throughout the range of the arroyo toad in California by protecting sufficient breeding and nonbreeding habitat.
- 2) Monitor the status of existing populations to ensure recovery actions are successful.
- 3) Identify and secure additional suitable arroyo toad habitat and populations.
- 4) Conduct research to determine the population dynamics and ecology of the species to guide management efforts and determine the best methods for reducing threats.
- 5) Develop and implement an outreach program.

Costs (minimum):

Year

1999	\$888,000
2000	357,000
2001	307,000
2002	143,000
2003	143,000
2004	125,000
2005	125,000
2006	125,000
2007	125,000
2008	125,000
2009	125,000
2010	125,000

Total Cost of Recovery (minimum):

\$2,713,000

Date of Recovery: Delisting could be initiated in 2010, if recovery criteria are met.

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ARROYO SOUTHWESTERN TOAD RECOVERY PLAN

PART I INTRODUCTION

Brief Overview

On December 16, 1994 the U.S. Fish and Wildlife Service determined the arroyo southwestern toad (*Bufo microscaphus californicus*) to be an endangered species (U.S. Fish and Wildlife Service 1994).

The arroyo southwestern toad (arroyo toad) originally was described from individual specimens collected at Santa Paula, Ventura County on May 22, 1912, and Big Tujunga Wash near Sunland, Los Angeles County on April 1, 1904 (Camp 1915). Over the next 70 years, collections and observations by zoologists found the arroyo toad in a number of isolated coast and desert drainages from southern California south into northwestern Baja California (Stebbins 1951, 1985; Figure 1). Because relatively little was known about this animal and it was often confused with the California toad (*Bufo boreas halophilus*), which is very common in the same region, detailed studies of the natural history of the arroyo toad were not conducted until the 1980s (Sweet 1992). These studies revealed that the northern populations exhibit habitat specialization that favors the shallow pools and open sand-gravel flood terraces of medium to large-sized intermittent or perennial streams that are flooded on a fairly regular basis. However, additional studies and observations in the southern portion of the range (Dan C. Holland, Ph.D., Principal Investigator, Camp Pendleton Amphibian and Reptile Survey, Fallbrook, CA; *in litt.* 1997; Robert N. Fisher, Ph.D., University of California at San Diego, pers. comm. 1997) have shown that arroyo toads breed in smaller streams (lower order), deep canyons (where breeding sites may be patchily distributed), and utilize upland habitats as both subadults and adults. These differences in ecology may be due to the differences in landscapes and available habitat over the range of the arroyo toad. The arroyo toad has evolved in a system that is inherently quite dynamic, with marked seasonal and annual fluctuations in climatic regimes, particularly rainfall. Natural climatic variations are likely to



Figure 1. Historic and current distribution of the arroyo toad in southern California and northern Baja California based on 173 locations from 1,196 museum records and 37 records from other sources (modified from Sweet 1992 and Jennings and Hayes 1994).

lead to annual fluctuations in arroyo toad populations that must be considered when determining recovery strategies, criteria, and actions.

Because arroyo toad habitats are favored sites for water storage reservoirs, flood control structures, roads, agriculture, urbanization, and recreational facilities such as campgrounds and off-highway vehicle (OHV) parks, many arroyo toad populations were reduced in size or extirpated (eliminated) due to extensive habitat loss from 1920-1980. The loss of habitat, coupled with habitat modifications due to the manipulation of water levels in many central and southern California streams and rivers, as well as predation from introduced species such as green sunfish (*Lepomis cyanellus*), fathead minnows (*Pimephales promelas*) and bullfrogs (*Rana catesbeiana*), caused arroyo toads to disappear from about 75 percent of the previously occupied habitat in California (Jennings and Hayes 1994). These threats, coupled with the limited natural occurrence of the arroyo toad (thought to be only 22 populations in California in 1994) and small populations that are susceptible to severe reduction in numbers due to collection and due to random naturally occurring events (such as extended droughts), resulted in the U.S. Fish and Wildlife Service first including this animal as a Category 2 candidate species on September 18, 1985 (50 Federal Register 181:37958-37967). It was later included under the same category in subsequent Fish and Wildlife Service publications of January 6, 1989 (54 Federal Register 4:554-579), and November 21, 1991 (56 Federal Register 225:58804-58836). The Fish and Wildlife Service was petitioned to list the arroyo toad under the Endangered Species Act on December 30, 1992, and a proposed rule was published on August 3, 1993 (58 Federal Register 147:41231-41237). The arroyo toad subsequently was listed as endangered on December 16, 1994 (59 Federal Register 241:64859-64866).

The arroyo toad recovery priority number is 9. Priority numbers are assigned on the basis of taxonomy and the degree and imminency of threat, with priority number 1C being given the highest priority number and 18 the lowest (U.S. Fish and Wildlife Service 1983). The arroyo toad is a subspecies with a moderate degree of imminent threat and a high probability of recovery.



Figure 2. Larval (above) and adult female (below) arroyo toads (*Bufo microscaphus californicus*), approximately life size. Larval photo courtesy of Samuel S. Sweet, University of California, Santa Barbara. Adult photo of specimen CAS 175636 by Mark R. Jennings.

Description and Taxonomy

The arroyo toad is a small (adults: snout-urostyle length (SUL) 55-74 millimeters (2.2-2.9 inches), dark-spotted toad of the family Bufonidae (Figure 2).

Although first described as a subspecies of the Great Plains toad (*B. cognatus*, Camp 1915), Myers (1930) found this toad differed in several important respects from the Great Plains toad and elevated it to specific status as *B. californicus*, a treatment that was followed by Pickwell (1947) and Wright and Wright (1949). Over the next 20 years, the arroyo toad also was considered a subspecies of *B. compactilis* (Linsdale 1940) and *B. woodhousii* (Shannon 1949). Since 1951, this toad has been considered a subspecies of the southwestern toad, *B. microscaphus californicus* (Stebbins 1951, 1966, 1985), with its closest relatives (*B. m. microscaphus*) found in the lower Colorado River basin (Price and Sullivan 1988). Sweet (1992) and Gergus (1994) indicate that the recommendation by Myers (1930) of species status for the arroyo toad probably is warranted.

Adult arroyo toads have a light-olive green or gray to tan dorsum with dark spots and warty skin (Stebbins 1951, 1985). The underside is white or buff and without dark blotches or spots (Samuel S. Sweet, Ph.D., University of California at Santa Barbara; pers. comm. 1997). A light-colored, V-shaped stripe crosses the head and the eyelids, and the anterior portion of the oval parotoid glands (just behind the eyes) are pale (Stebbins 1951). There is usually a light area on each side of the sacral hump and in the middle of the back. The arroyo toad generally lacks a middorsal stripe (Stebbins 1951, 1985). However, if a middorsal stripe is present, it is present only on part of the dorsum (Jennings unpubl. data; D. C. Holland, *in litt.* 1997).

Adult males give an advertisement call during the breeding period (late January or February to early June). The call is a soft, high, whistled trill, generally lasting from 4 to 10 seconds (Stebbins 1951, Sullivan 1992). To the untrained observer, it is often mistaken for the call of an insect. Adult and subadult males may also emit a release call (which is a series of chirps) when grasped by another male toad or when handled behind the forelimbs by humans. Females do not emit such calls (Sweet 1992).

Juvenile arroyo toads have a white-gray-tan dorsum with small dark spots and

gray reticulations (Sweet 1992). The venter is white. The large parotoid glands are not evident on young juveniles, but the V-shaped light mark that crosses the eyelids is prominently visible (Sanders 1950).

Larval arroyo toads have considerable variation in color depending on their age. By 2-3 weeks after hatching, at 9-10 millimeters (0.35-0.39 inch), the dark-colored larvae have faint gold crossbars on the upper surface of the base of the tail (Sweet 1992; Figure 3). Within a few days of this, the larvae become uniformly tan dorsally with the exception of some irregular dark crossbars (Stebbins 1951, Figure 3). Ventrally, the larvae are opaque white (Sweet 1992). Larvae usually metamorphose at 28-40 millimeters (1.10-1.58 inches) in length.

The arroyo toad lays small darkly-pigmented eggs, 1.4-2.2 millimeters (0.055-0.087 inch) in diameter, in two parallel gelatinous strings, 3.0-10.7 meters (10-35 feet) long (Figure 4; Sweet 1992). Females usually lay 2,000-10,000 (mean = 4,715) eggs in shallow water (mean = 3.5 centimeters (1.4 inches); Sweet 1992).

Arroyo toads can be distinguished from sympatric California toads by the following characters:

- 1) Adult California toads usually have a middorsal stripe, are larger (6-12 centimeters (2.5-5 inches)), have dark spots on the chest, and tend to walk or intersperse hopping with walking. Adult arroyo toads normally lack a middorsal stripe, are smaller, lack spotting on the chest, and usually hop rather than walk (Stebbins 1985, Sweet 1992).
- 2) The breeding call of sympatric populations of the California toad is a very soft, high-pitched, plinking or "chup" sound. The breeding call of the arroyo toad is a long, musical trill (Davidson 1995).
- 3) Juvenile California toads usually have large dark spots on the dorsum, have spots on the chest and lack a V-shaped stripe between the eyes. Juvenile arroyo toads have small spots on the dorsum, lack spots on the chest, and have a V-shaped stripe between the eyes (Sweet 1992).

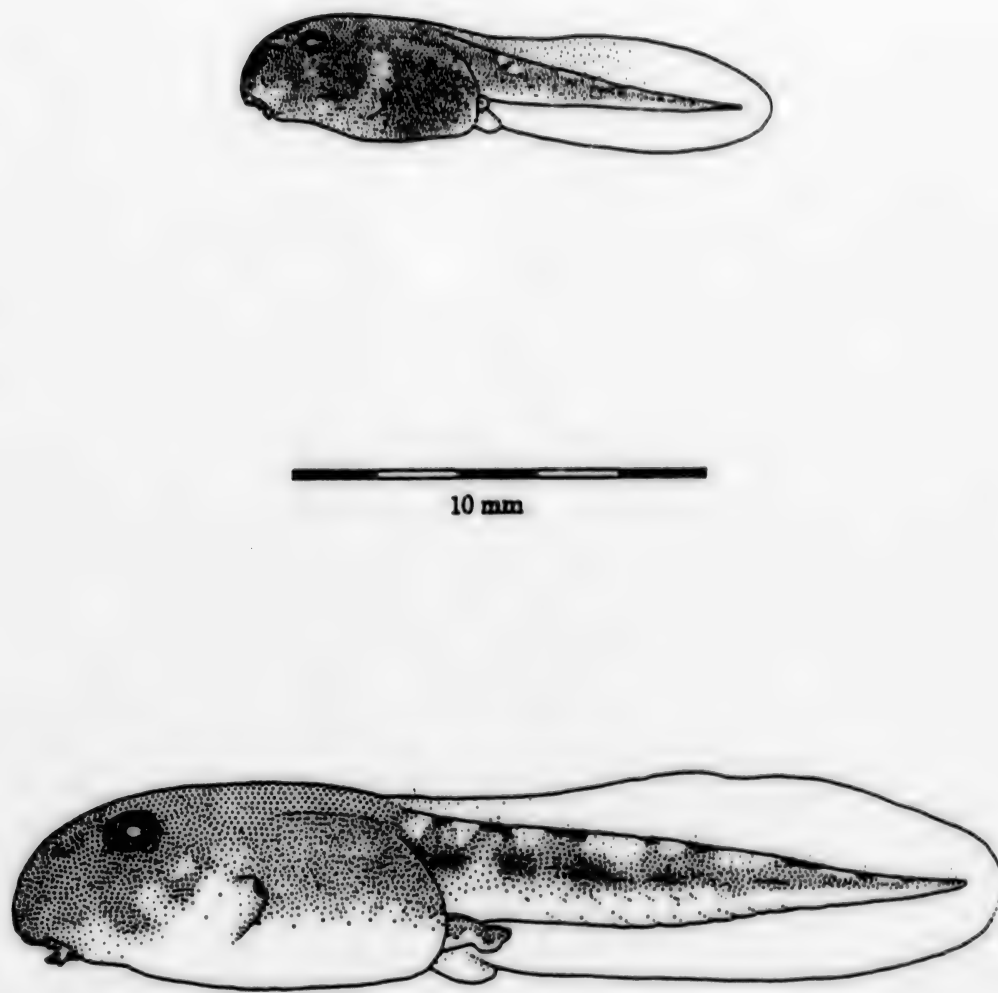


Figure 3. Arroyo toad larvae at 2-3 weeks (upper) and 4 weeks (lower) after hatching (from Sweet 1992).



Figure 4. Egg clutch and adult arroyo toads in amplexus (from Sweet 1992). This particular egg clutch (most of which is not shown in the photograph) is 5.8 meters (19 feet) long.

4) Larval California toads are dark gray to jet black on the sides and back and pale cream or tan underneath, tend to aggregate (often around submerged vegetation), and are almost constantly in motion. Larval arroyo toads are usually tan with dark crossbars on the tail and opaque white underneath, tend to be solitary, and move in short bursts (Sweet 1992). They are also more blunt-nosed and have more dorsal-ventrally flattened bodies (Figure 5).

5) Embryos and envelopes of California toads tend to average larger sizes (1.7-2.4 millimeters (0.067-0.095 inch); 3.8-6.7 millimeters (0.15-0.26 inch)), more eggs (mean = 8,285), and longer clutch lengths (4.6-17.1 meters (15-56 feet), Sweet 1992, Figure 6). California toad eggs are laid in both shallow and deeper water, and usually are tangled around vegetation. Embryos and envelopes of egg clutches of arroyo toads tend to average smaller sizes (1.4-2.2 millimeters (0.055-0.087 inch); 2.8-4.7 millimeters (0.11-0.18 inch)), fewer eggs (mean = 4,715), and shorter clutch lengths (3.0-10.7 meters (10-35 feet)). They are laid in shallower water, and usually are deposited in the open.

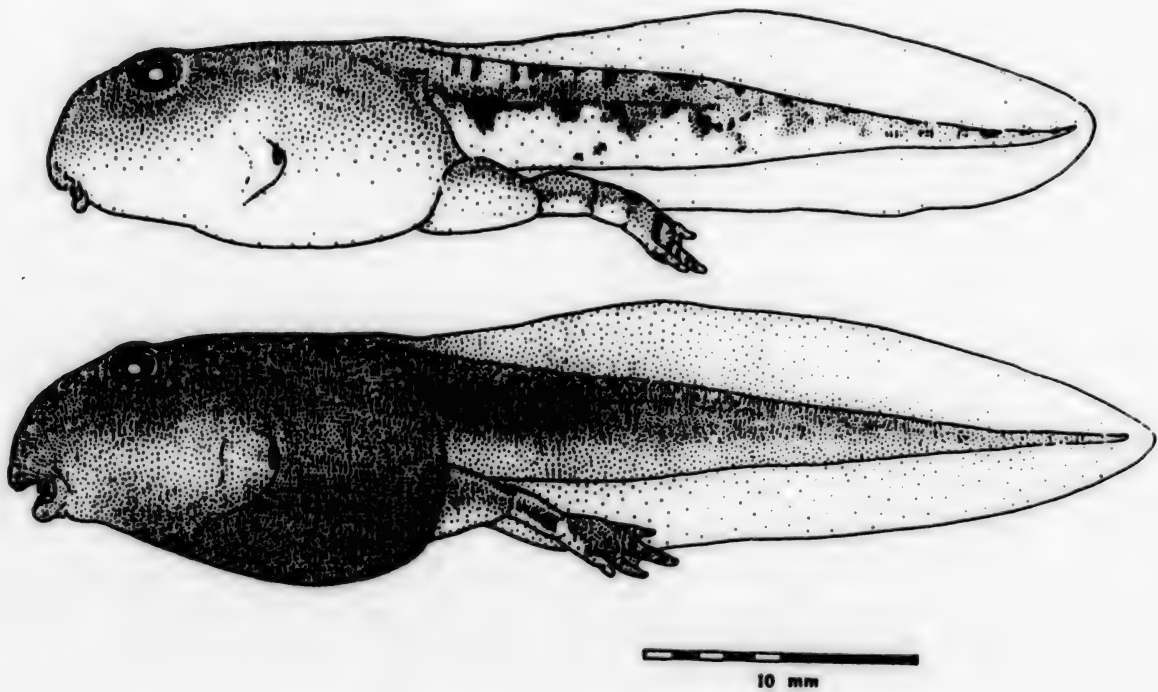


Figure 5. Larvae of the arroyo toad (upper) and California toad (lower) at 8 weeks of age (from Sweet 1992).

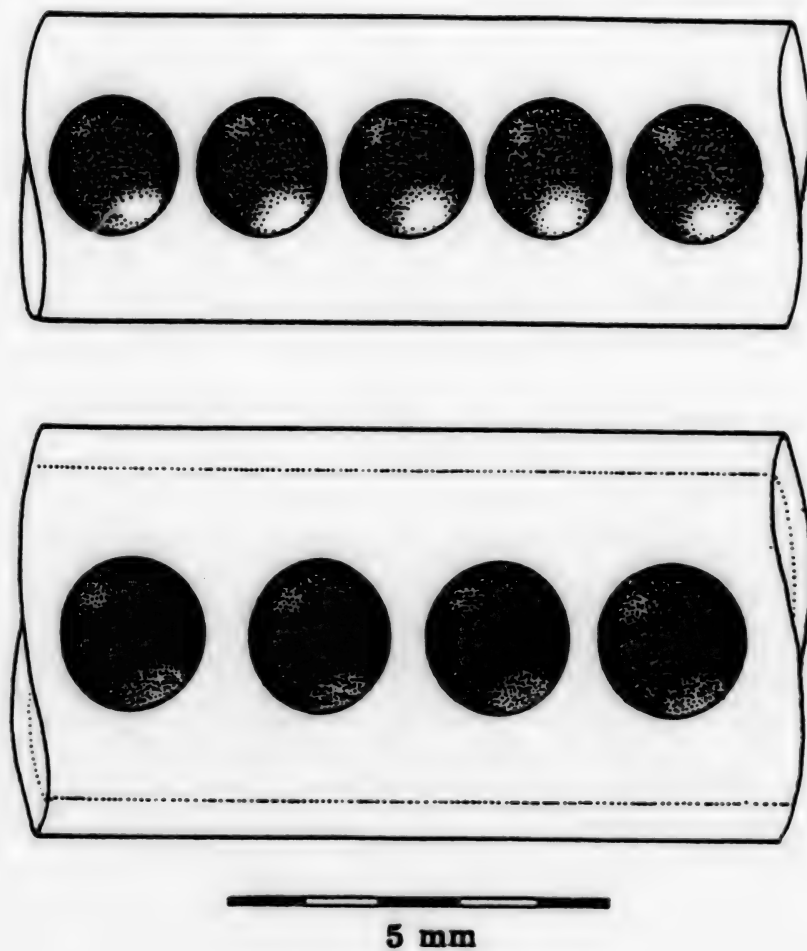


Figure 6. Embryos and envelopes of the arroyo toad (upper) and California toad (lower) (from Sweet 1992).

Distribution and Population Status

The historical range of the arroyo toad extended from the upper Salinas River system on Fort Hunter Liggett Military Reservation, Monterey County (U.S. Army Reserve Command 1996), south through the Santa Ynez, Santa Clara, and Los Angeles river basins (Myers 1930, Sanders 1950, Stebbins 1951, Sweet 1992) and the coastal drainages of Orange, Riverside, and San Diego counties to the Arroyo San Simeon system, about 16 kilometers (10 miles) southeast of San Quintin, Baja California, Mexico (Tevis 1944, Gergus et al. 1997; Figure 1).

Although the arroyo toad occurs principally along coastal drainages, it also has been recorded at several locations on the desert slopes of the Transverse and Peninsular mountain ranges south of the Santa Clara River (Patten and Myers 1992, Jennings and Hayes 1994).

The elevational range for the arroyo toad extends from near sea level to about 2,440 meters (8,000 feet) in Baja California (Welsh 1988; Beaman et al. 1995). Currently, most arroyo toad populations in the northern and central parts of the range are restricted to 300-1,370 meters (1,000-4,500 feet), perhaps due to widespread habitat loss at the lower elevations. The upper elevational limit may be due to an inability to withstand cooler temperature regimes, especially during the larval stage (Sweet 1992).

Since the early part of the century, arroyo toads have been found in at least 22 drainages in California. The following discussion of the status of arroyo toads in each of these drainages is covered north to south by drainage. Museum acronyms follow those of Leviton et al. (1985), and are provided below.

CAS	California Academy of Science, San Francisco, CA
LACM	Los Angeles County Natural History Museum, Los Angeles, CA
AMNH	American Museum of Natural History, New York, NY
UCSB	University of California, Santa Barbara, CA
SDSNH	San Diego Natural History Museum, San Diego, CA
CSPUP	California State Polytechnic University, Pomona, CA
UMMZ	Museum of Zoology, University of Michigan, Ann Arbor, MI

1) Salinas River Basin, Monterey and San Luis Obispo counties:

Arroyo toads originally were discovered in the upper Salinas River Basin near Santa Margarita, San Luis Obispo County, on June 12, 1936 (Miller and Miller 1936; Figure 7). Surveys of the area during the 1980s and 1990s located no arroyo toads (S. S. Sweet, pers. comm. 1997). The available arroyo toad habitat probably was affected adversely by the construction of Santa Margarita Dam, approximately 16 kilometers (10 miles) upstream from the collection site.

Arroyo toads were discovered in 1996 on the Fort Hunter Liggett Military Reservation along approximately 8 kilometers (5 miles) of the San Antonio River in the upper Salinas River Basin, southern Monterey County (U.S. Army Reserve Command 1996; Figure 7). This location, although upstream from Lake San Antonio, is about 64 kilometers (40 miles) downstream in the Salinas River drainage from the historic Santa Margarita site. The size of the adult population along the San Antonio River is currently unknown, but arroyo toads were detected along approximately 27 kilometers (17 miles) of the river in 1997 (Heinz Hormann, U.S. Army Reserve Command, *in litt.* 1997). The elimination of grazing along the river in 1991 may have been a factor in the expansion of the population. The arroyo toads at this location currently are affected by introduced aquatic predators (such as green sunfish and bullfrogs) and by military activities in the riparian zone. Management actions to protect arroyo toad habitats are being implemented.

2) Sisquoc River, Santa Maria River Basin, Santa Barbara County:

Arroyo toads have been reported from the Sisquoc River, Los Padres National Forest, Santa Barbara County, since June of 1991 (Campbell et al. 1996; Figure 7). The area of suitable habitat for the arroyo toad extends from the vicinity of the junction with Manzana Creek upstream to the vicinity of Sycamore Campground (elevation 350-625 meters (1,150-2,050 feet)), a distance of about 14.5 kilometers (9 miles). Apart from some grazing and low-intensity recreational use, this section of the Sisquoc River is essentially free from habitat disturbances and introduced aquatic

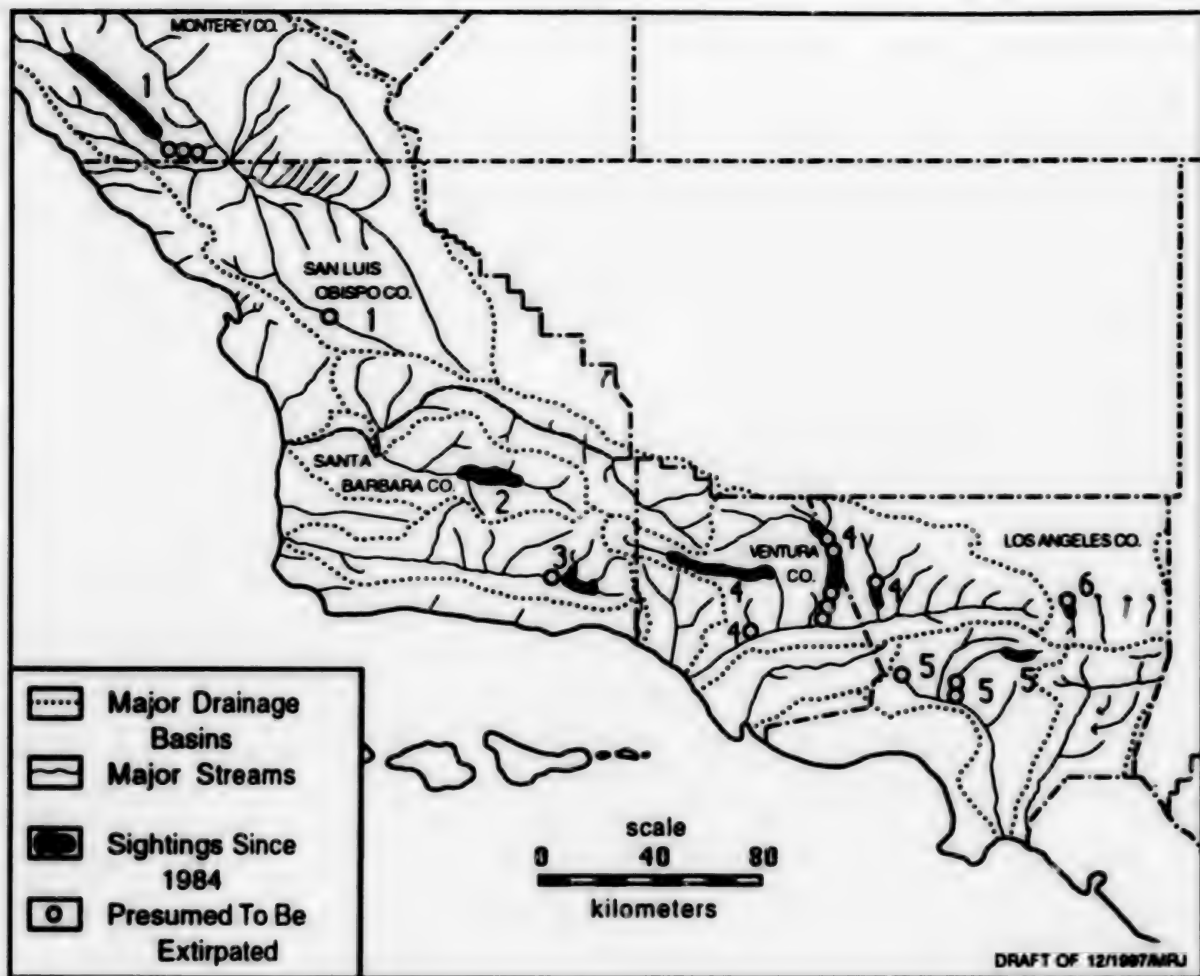


Figure 7. Historic and current distribution of the arroyo toad in Monterey, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles Counties (modified from Campbell et al. 1996). Numbers correspond to drainages mentioned in the text.

predatory species that affect arroyo toad populations elsewhere (Sweet 1992). The number of adult arroyo toads present in this population is unknown.

It is possible that arroyo toad populations are located on the lower reaches of the Sisquoc River and on other tributaries of the Santa Maria River such as the Cuyama River and Alamo Creek. These areas should be surveyed for suitable habitat and toads.

3) Santa Ynez River Basin, Santa Barbara County:

Arroyo toads are present on a short segment of the upper Santa Ynez River, Santa Barbara County, between Mono Creek and the vicinity of Middle Santa Ynez Campground (430-520 meters (1,400-1,700 feet)), a distance of about 4.8 kilometers (3 miles) (Figure 7). They also are present on the lower reaches of Mono and Indian Creeks from the confluence of the Santa Ynez River to elevations of about 520 meters (1,700 ft) and 460 meters (1,500 feet) respectively, a distance of about 5.6 kilometers (3.5 miles) (Figure 7). The main Santa Ynez River populations probably represent remnants of a much larger population in the drainage that was impacted by the construction during the 1920s and subsequent operation of Gibraltar Dam, and by the construction during the 1930s and subsequent operation of Juncal Dam. The most recent studies on these populations indicate that they are currently small, with the largest population of toads found in Mono Creek. All of these arroyo toad populations are threatened by OHVs and recreational use of roads and campgrounds in the area (Sweet 1992, 1993). The toads along the Santa Ynez River additionally are affected by introduced fishes (especially green sunfish, bluegill (*Lepomis macrochirus*), and fathead minnows), bullfrogs, and flow regulation of the river (Sweet 1993). Racoons (*Procyon lotor*) and opossums (*Didelphis virginianus*) also may threaten local toad populations, especially when released by animal control agencies during the toad's breeding season, when toads are very susceptible to predation. Tamarisk has invaded some sandy terraces, reducing foraging habitat. Interactions of current small population sizes with natural events such as fires, floods and droughts, and human-induced changes, including collecting, may lead to local extirpation of some populations.

4) Santa Clara River Basin, Ventura and Los Angeles counties:

Arroyo toads were discovered in the Santa Clara River Basin on May 22, 1912, at Santa Paula, Ventura County (Camp 1915; Figure 7). This site (now located along Highway 150) apparently was part of a formerly extensive oak (*Quercus* spp.) woodland on the floodplain near Santa Paula Creek. The creek floodplain from 75-120 meter (250-400 feet), a distance of about 4.8 kilometer (3 miles), has been urbanized extensively and arroyo toads have been extirpated from the area (Jennings, unpubl. data).

A large number of arroyo toads persists along Sespe Creek, Los Padres National Forest, Ventura County, from about Hot Springs Canyon upstream to the mouth of Tule Creek (Figure 7; Sweet 1992). The amount of stream distance with suitable arroyo toad habitat is 24 kilometers (15 miles) and the elevational range is 690-1,040 meters (2,250-3,400 feet). The upper half of the portion of Sespe Creek inhabited by arroyo toads had large areas of excellent habitat and numerous high-quality breeding pools, while the lower portion supports few stream terraces with suitable substrates, and fewer pools of suitable quality as arroyo toad breeding sites (Sweet 1992). Repeated surveys of Sespe Creek during the 1980s and 1990s revealed that the arroyo toad population fluctuated between approximately 130 and 250 adults (Sweet 1992, 1993). The Lions Creek fire in 1991 led to severe erosion in approximately half of the upland habitat in the upper half of the creek basin, reducing the extent and quality of the habitat. Current impacts to this population include recreational activities such as OHVs, fishing, camping, catastrophic events such as fires, and the spread of introduced aquatic predators such as green sunfish, black bullheads (*Ameiurus melas*), and bullfrogs.

Along Piru Creek, Ventura and Los Angeles Counties, arroyo toads historically were found between the mouth (205 meters (660 feet)) and Bear Gulch (945 meters (3,100 feet), Figure 7, Sanders 1950). With the construction of Lake Piru in the 1950s and Pyramid Lake in the 1970s, arroyo toads were eliminated from much of their historic range in the drainage and now are restricted to short segments above each of the two reservoirs (Sweet 1992). The lower segment is from Blue Point Campground upstream to lower Piru Gorge (340-410 meters (1,100-1,350 feet)), a distance of 5.6 kilometers (3.5 miles), and the upper segment is from the headwaters of Pyramid Lake upstream to Bear Gulch (760-

945 meters (2,500-3,100 feet)), a distance of 7.2 kilometers (4.5 miles). There is also a population of arroyo toads in the lower 1.6 kilometers (1 mile) section of Agua Blanca Creek (Sweet 1992). Upper Piru Creek has generally small populations of arroyo toads distributed in a range of good to marginal habitats, while lower Piru Creek has generally larger numbers of arroyo toads distributed over areas of good to excellent habitat that generally are undisturbed by human activities (Sweet 1992). Toads in both areas are affected by recreational activities. The upper section of Piru Creek also has been impacted by placer mining and OHV use. The lower section of Piru Creek is affected by the introduction of bullfrogs and exotic fishes (especially green sunfish, black bullhead, prickly sculpin (*Cottus asper*), and largemouth bass (*Micropterus salmoides*)), recreational activities in and around campgrounds, flow regulation from Pyramid Lake, and grazing of the riparian zone by livestock (Sweet 1992, Campbell et al. 1996).

Along Castaic Creek, Angeles National Forest, Los Angeles County, arroyo toads have been found recently below the dam at Castaic Lake, over a distance of 3.2 kilometers (2 miles), as well as above the reservoir in the dredge spoils, over a distance of about 1.6 kilometers (1 mile) (Campbell et al. 1996; Frank T. Hovore, Planning Consultants Research, Santa Monica, CA; pers. comm. 1997) (Figure 7). The toads probably were more widespread in the Castaic Creek drainage between 440-480 meters (1,450-1,575 feet) before the reservoir was constructed in the 1970s. Analysis of surveys conducted during 1996 indicated that there were about 25 adults at the location above the reservoir (William J. Brown, Jr., Angeles NF, pers. comm. 1997) and about 50 adults below the reservoir (F. T. Hovore, pers. comm. 1997). Toads at both sites currently are affected by exotic aquatic predators, OHVs, flooding, and recreational activities. Toads at the lower site are threatened also by water flow regulation and potential urban development of the surrounding hillsides (Campbell et al. 1996).

Potential habitat for arroyo toads probably exists in the upper Santa Clara River drainage, Los Angeles County, in some of the other canyons that drain from the north. Likely candidates include parts of the San Francisquito Canyon drainages and Bouquet Canyon drainages (S. S. Sweet, pers. comm. 1997) (Figure 7).

5) Los Angeles River Basin, Los Angeles County:

Arroyo toads initially were found in the Los Angeles River Basin on April 1, 1904, along Big Tujunga Wash near Sunland, Los Angeles County (Camp 1915) (Figure 7). Between 1915 and 1954, dozens were collected in Big Tujunga Canyon near the present-day crossing of Interstate 210 (CAS 39868-39874; LACM 1040, 11513-11522; AMNH 14510). Although arroyo toads apparently have been extirpated from the Big Tujunga drainage below the Angeles National Forest boundary, they are present on the Forest in Big Tujunga Creek, Mill Creek, and Alder Creek drainages above Tujunga Reservoir between 760 and 1,070 meters (2,500 and 3,500 feet) (Figure 7). During recent surveys, toads were found along about 10 kilometers (6 miles) of stream in the four drainages (W. J. Brown, Jr., pers. comm. 1997). Toads at these locations are affected by recreational activities (such as hiking, fishing, and camping), introduced bullfrogs, and the spread of *Arundo donax*.

An arroyo toad was collected on July 6, 1970, from the westernmost part of the Los Angeles Basin in the Chatsworth Drain, Canoga Park, Los Angeles County, at an elevation of 242 meters (795 feet) (UCSB 9382) (Figure 7). The entire area has been urbanized and arroyo toads are now extirpated from this part of the basin (S. S. Sweet, pers. comm. 1997).

There were several reports of sightings of arroyo toads during June, 1992, in Arroyo Seco below Devil's Gate near Pasadena, Los Angeles County (e.g., see York 1992). Subsequent careful examination of the site revealed many hundreds of juvenile California toads present, but no arroyo toads (Michael C. Long, Eaton Canyon Nature Center, pers. comm. 1997). The site is within the historic range of the arroyo toad and probably contained arroyo toad habitat at the turn of the century, but appears to be unsuitable below the reservoir because of stabilization of stream flows through the drainage. However, arroyo toads were located along a small tributary of Arroyo Seco above Devil's Gate Reservoir in 1996 (Caltrans 1996) and again in 1997 (Krueger, *in litt.* 1997). The amount of habitat and the arroyo toad population size are currently unknown. Impacts include introduced predators and recreational activities (including hiking, fishing, horseback riding, and biking).

6) Little Rock Creek Basin, Los Angeles County:

Arroyo toads in this drainage originally were discovered on May 8, 1970, at Joshua Tree Campground near the upper end of Little Rock Reservoir, Angeles National Forest, Los Angeles County, at 1,040 meters (3,400 feet) (Figure 7) (M. C. Long, pers. comm. 1997). The toads currently appear to be restricted to a 4.8 kilometers (3 miles) stretch of stream habitat above Little Rock Reservoir and numbered approximately 20 adults in 1996 (W. J. Brown, Jr., pers. comm. 1997). The population is threatened by introduced aquatic predators (Louisiana red-swamp crayfishes (*Procambarus clarkii*), various fish species, and bullfrogs) and extensive OHV use along the creek terraces (Jennings, unpubl. data). There are also major campgrounds on the creek that attract heavy recreational use during the summer. Since 1996, the Angeles National Forest has closed access to the stream and stream banks from April 1 to October 1, from Santiago Creek through the campground for protection of the arroyo toad.

7) Mojave River Basin, San Bernardino County:

Although an arroyo toad was collected in the Mojave River at Victorville, San Bernardino County, by Loye Miller on July 7, 1906 (LACM 11367), the species was not recorded again from the drainage until Laurence Monroe Klauber collected several specimens at Victorville while conducting herpetological surveys on April 17, 1930 (SDSNH 2481-2482; 2542-2543). Since then, arroyo toads were found to be very common in the drainage from Miller Canyon, Deep Creek, and the Forks of the Mojave (1,070 meters (3,500 feet)) downstream to below Victorville (825 meters (2,700 feet)), a distance of about 37 kilometers (23 miles) (Jennings and Hayes 1994) (Figure 8). Hundreds of specimens were collected in the region now under Silverwood Lake and in the vicinity of the Mojave River Forks Dam between 1940 and 1970 (SDSNH 65641-65661; LACM 11371-11396, 11401-11512, 11523-11821, 74545-74548, 88007-88014, 91832, 125968-125969; CSPUP 46-49, 625, 638; UMMZ 113731) and this was the location of Cunningham's (1962) observations of habitat use and behavior during the late 1950s and early 1960s. Arroyo toads were also common in parts of Deep Creek from its confluence with the Mojave River to 1,310 meters (4,300 feet) (Beaman et al. 1995). With construction of the Mojave River Forks Dam in the 1960s and Silverwood Lake in the 1970s, portions of the arroyo toad habitat in the basin were eliminated through direct inundation and alteration of water flow patterns.

Adult arroyo toads are seen below the dam, but heavy OHV use may preclude sufficient successful recruitment to maintain the population. Introductions of beaver in the main Mojave River also have eliminated shallow breeding areas (D. Hyde-Sato, pers. comm. 1997). Arroyo toad populations currently appear to be restricted to the lower portions of Miller Canyon and the West Fork of the Mojave River, Little Horsethief Creek, and the lower and middle portions of Deep Creek on the San Bernardino National Forest. All of these populations are affected by introduced fishes and bullfrogs and recreational activities such as camping, fishing, and OHVs. The Little Horsethief Creek arroyo toad population is threatened by gold prospecting activities, and the Deep Creek population has been impacted by grazing (Steve A. Loe, San Bernardino NF, *in litt.* 1997).

8) Whitewater River Basin, Riverside County:

Patten and Myers (1992) discovered a small population of arroyo toads in the Whitewater River, Riverside County, 3-5 kilometers (2-3 miles) north of Interstate 10 at an elevation of about 420 meters (1,375 feet). The arroyo toads are found with California toads and red-spotted toads (*B. punctatus*). The toads are impacted by water manipulation and OHV use. The extent of arroyo toad breeding habitat in the basin is unknown. Most of the land is managed by Bureau of Land Management and San Bernardino National Forest.

9) Santa Ana River Basin, Orange and Riverside counties:

Arroyo toads historically were present in the Santiago Creek Basin and the San Jacinto River Basin. Toads first were found in Santiago Canyon on May 18, 1974, along Santiago Canyon Road, 2.8 kilometers (1.7 miles) north of Bolero Lookout, Orange County (Fred M. Roberts, Jr., U.S. Fish and Wildlife Service, Carlsbad, CA; unpubl. data) (Figure 8). Subsequent examination of the canyon during the 1970s and 1980s revealed arroyo toads in Baker Canyon and at the mouth of Silverado Canyon (R. N. Fisher, pers. comm. 1997). The arroyo toads apparently were restricted to about a 10 kilometers (6 miles) section of stream above Santiago Reservoir (Irvine Lake) at elevations between 250 and 340 meters (820 and 1,100 feet). According to Peter H. Bloom (Western Foundation of Vertebrate Zoology, Camarillo, CA; pers. comm. 1997), there have been no sightings of arroyo toads in this area during the 1990s. The entire area of arroyo

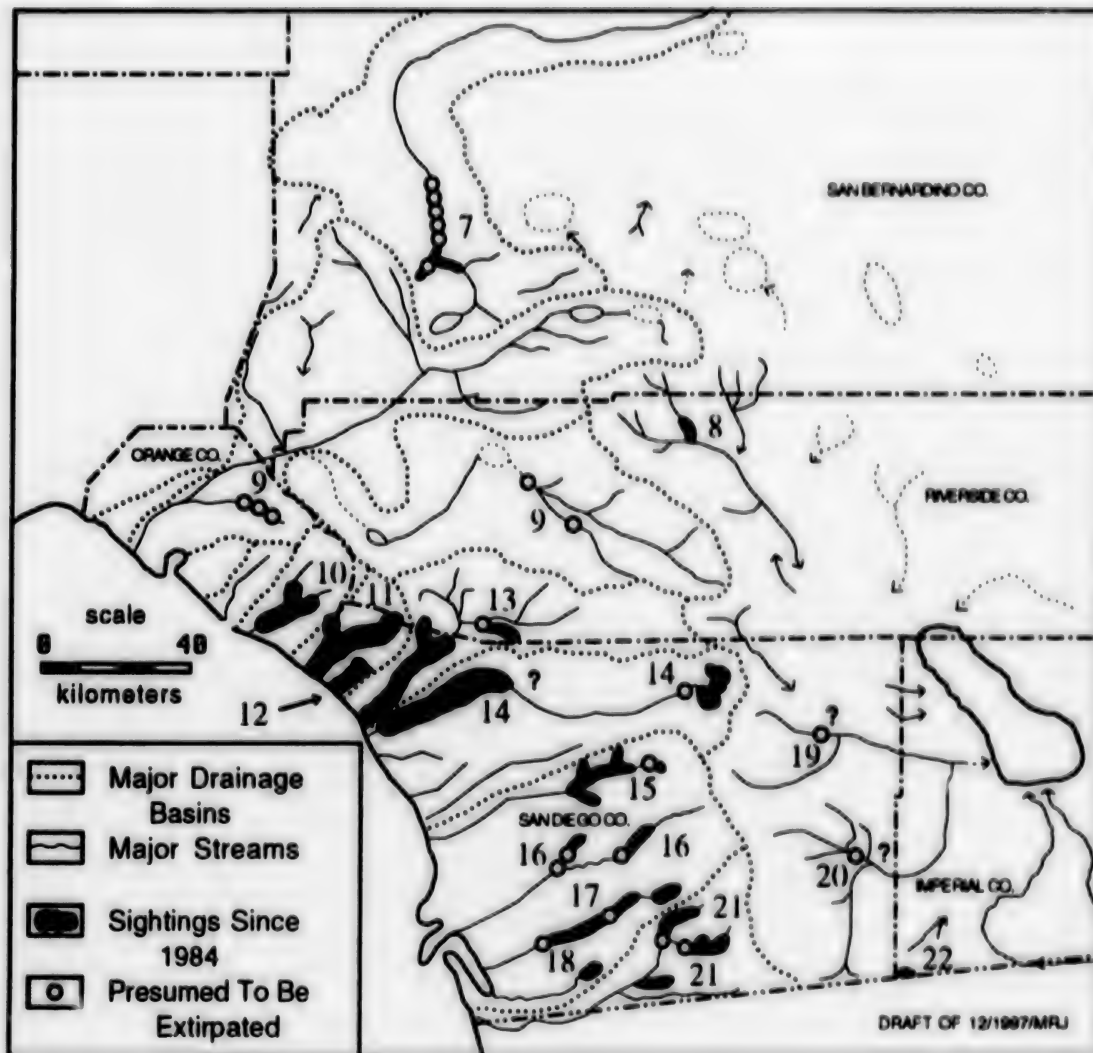


Figure 8. Historic and current distribution of the arroyo toad in Orange, Riverside, San Bernardino, San Diego, and Imperial Counties (modified from Campbell et al. 1996). Numbers correspond to drainages mentioned in the text.

toad habitat is owned by the Irvine Company and if the population is still extant, it currently is threatened by sand and gravel operations, water diversions (including groundwater pumping), agricultural activities, urban development, and introduced aquatic predators such as green sunfish.

Arroyo toads in the San Jacinto River were recorded initially on July 24, 1953, 8 kilometers (5 miles) east of Hemet, Riverside County (LACM 11374) (Figure 8). Arroyo toads at that location apparently were extirpated due to extensive habitat loss along that portion of the river due to urbanization (Jennings and Hayes 1994). An additional May, 1975, record exists for arroyo toads in lower Bautista Canyon, Riverside County, which is a tributary of the San Jacinto River (Glenn R. Stewart, Ph.D., California State Polytechnic University at Pomona; unpubl. data) (Figure 8). However, this part of Bautista Canyon also has undergone substantial urban development over the past 20 years and arroyo toads apparently have been extirpated at the site (Jennings and Hayes 1994). Habitat probably still exists along both the San Jacinto River and Bautista Creek in the San Bernardino National Forest.

10) San Juan Creek Basin, Orange and Riverside counties:

Arroyo toads originally were discovered in San Juan Creek on July 12, 1974, at about 1.6 kilometers (1.0 mile) southwest of the Lower San Juan Picnic Area, Cleveland National Forest, Orange County (F. M. Roberts, Jr., unpubl. data) (Figure 8). Subsequent surveys by the California Department of Fish and Game (CDFG) and the Cleveland National Forest found arroyo toads in the drainage from Interstate 5 near San Juan Capistrano, Orange County, upstream through Ronald W. Caspers Wilderness Park and the Cleveland National Forest, to the Lower San Juan Campground area, Riverside County (P. H. Bloom, pers. comm. 1997; F. M. Roberts, Jr., pers. comm. 1997). There are also arroyo toads in the lower part of Bell Canyon and in Trabuco Creek (D. C. Holland, *in litt.* 1997). In addition to some exotic fishes, bullfrogs, and crayfish in the creek and recreational activities in the riparian zones, arroyo toads currently are affected by county flood control activities and sand and gravel mining operations in the lower parts of San Juan Creek (P. H. Bloom, *in litt.* 1997). The most potentially damaging activity is the annual moving of riparian gravels in the river bottom at Caspers Wilderness Park with the use of heavy equipment. There are also a few arroyo toads killed on

Highway 74 each year.

11) San Mateo Creek Basin, Orange and San Diego counties:

Arroyo toads were discovered first at the mouth of San Mateo Creek, San Diego County, on April 2, 1932, when a series of four specimens were collected by L. M. Klauber (SDSNH 7404, 7423-7425). The site is near the present Interstate 5 highway bridge on Camp Joseph H. Pendleton Marine Corps Base (Camp Pendleton). During 1995-1997, surveys documented arroyo toads from the mouth of San Mateo Creek, upstream on Cristianitos Creek, Talega Canyon, and San Mateo Canyon to the Marine Corps Base boundary (D C. Holland, pers. comm. 1997; Figure 8). Arroyo toads also are present in Cristianitos Creek, Gabino Canyon, and La Paz Canyon, upstream from the Marine Corps Base boundary to the Girl Scout Camp (P. H. Bloom, pers. comm. 1997) (Figure 8). The toads are present also in the headwaters of San Mateo Creek on the adjacent Cleveland National Forest (John Stephenson, Cleveland NF, pers. comm. 1997). The overall amount of arroyo toad stream habitat within the drainage is over 42 kilometer (26 miles) (D. C. Holland, *in litt.* 1997). The exact number of adult arroyo toads in this population is unknown, but there is a large amount of habitat available. Toads in this drainage currently are impacted by introduced aquatic predators (especially green sunfish and bullfrogs), sand and gravel mining, travel on roads, livestock grazing, and military activities (especially training in the riparian zones). The toad's riparian habitat also is threatened by the widespread introduction of exotic vegetation (especially tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*)) that is stabilizing stream terraces.

The lower portions of the San Mateo Creek basin and the following two basins, San Onofre Creek and Santa Margarita River, which are located on Camp Pendleton, may be the only remaining coastal plain lands in southern California on which the arroyo toad occurs within 10 kilometers (6 miles) of the coastline and down to the coastal marsh zone. As such, they may harbor populations with phenotypic characteristics that are now limited in representation throughout the range of the arroyo toad in California. The lack of agricultural and urban development on these lands probably has allowed these populations to persist.

12) San Onofre Creek Basin, San Diego County:

Arroyo toads were found in the lower San Onofre Creek drainage, at least to 366 meters (1,200 feet) in Jardine Canyon, during surveys conducted during 1995-1997 on Camp Pendleton, (D. C. Holland, pers. comm. 1997) (Figure 8). Currently, the known extent of arroyo toad breeding habitat is about 11 kilometers (7 miles) for San Onofre Creek and 5 kilometers (3 miles) for Jardine Canyon (D. C. Holland, pers. comm. 1997). The size of the adult population is unknown. Overland movement of arroyo toads between the San Mateo Creek and San Onofre Creek systems may be possible. Like the San Mateo Basin toads, the San Onofre Basin arroyo toads currently are affected by introduced fishes (especially green sunfish) and bullfrogs, and military activities (especially training in the riparian zones), as well as the widespread introduction of exotic vegetation (especially tamarisk and giant reed) that is stabilizing stream terraces.

13) Santa Margarita River Basin, San Diego and Riverside counties:

Arroyo toads have been found in the Santa Margarita River Basin since June, 1929 when L. M. Klauber collected a series of specimens from the river 3.2 kilometers (2 miles) northwest of Fallbrook (SDSNH 12049-12059; MVZ 11206-11211). Over the next 68 years, arroyo toads have been found over much of the drainage below 610 meters (2,000 feet). Specific streams include the main Santa Margarita River from the mouth to 150 meters (500 feet) elevation, De Luz Creek from the confluence with the Santa Margarita River to 120 meters (400 feet) elevation, Roblar Creek from the confluence with the Santa Margarita River to 110 meters (350 feet) elevation, Sandia Creek, Temecula Creek from Vail Lake to Aguanga, and Arroyo Seco Creek from Vail Lake to above Dripping Springs Campground (Figure 8).

Arroyo toads in all of the above drainages are being affected negatively by introduced aquatic predators (fishes, crayfish, and bullfrogs), roads and road crossings, and introduced plants. Over half of the Santa Margarita River, as well as the lower part of De Luz Creek and all of Roblar Creek are under the management of Camp Pendleton. About half of the Arroyo Seco Creek drainage is managed by the Cleveland National Forest. The rest of the arroyo toad habitat in the Santa Margarita River Basin is on private lands or under the management of

Fallbrook Water District. As indicated previously, toads on military lands are impacted by military activities, especially training maneuvers in the riparian zones. Toads on private lands are affected by livestock grazing, manipulation of stream flows, OHVs, and agricultural activities. Toads on the Cleveland National Forest are affected by recreational activities, especially in the region of Dripping Springs Campground.

14) San Luis Rey River Basin, San Diego County:

Arroyo toads initially were found in the San Luis Rey River on May 23-24, 1927, when Joseph Richard Slevin collected a large series of specimens on the river 4.8 kilometers (3 miles) west of Bonsall, San Diego County (CAS 62908-62915). Over the next 70 years, arroyo toads have been found in many parts of the drainage, including the main and West Fork San Luis Rey River, Pala Creek, and Agua Caliente Creek. Historically, arroyo toads were noted from near the mouth of the San Luis Rey River (L. M. Klauber, unpubl. field notes, April 2, 1932) to Indian Flats Campground in the Cleveland National Forest (CAS 173699-173700), a distance of about 32 kilometers (20 miles) and an elevational range of 25-1,280 meters (80-4,200 feet). Today, arroyo toads have scattered breeding sites within the main river down to the city of Oceanside, and another disjunct breeding site above Lake Henshaw to Indian Flats Campground (825-1,280 meters (2,700-4,200 feet)). There are also arroyo toads currently inhabiting the West Fork of the San Luis Rey River to above the Barker Valley Trail (1,250 meters (4,100 feet)), and Agua Caliente Creek to above Warner Springs (Jennings, unpubl. data). The status of the Pala Creek population is currently unknown. There are probably arroyo toads in other streams of the San Luis Rey River Basin, especially above Lake Henshaw. The drainage is largely in private lands in the lower section, Indian Reservations in the middle and upper sections, and the Cleveland National Forest in the upper section. Toads in the main river below Lake Henshaw are threatened by encroaching urban development and are being impacted by agricultural activities, water diversions, flood control activities, sand and gravel mining, and introduced plants and animals (especially fishes and bullfrogs). Toads in the drainage above Lake Henshaw are threatened by urban development, and affected by water diversions, livestock grazing, introduced predators (especially bullfrogs), recreation, and road use, much of which occur on Vista Irrigation District and private lands. Grazing has been excluded from the riparian

areas on Cleveland National Forest.

15) San Dieguito River / Santa Ysabel Creek Basin, San Diego County:

Arroyo toads originally were discovered in the San Dieguito River / Santa Ysabel Creek Basin on April 26, 1935, when Wallace F. Wood collected a specimen in Witch Creek (MVZ 29833). Since then, arroyo toads have been found in Guejito Creek, Santa Maria Creek, Pamo Valley (Temescal Creek), and San Pasqual Valley (Campbell et al. 1996) (Figure 8). Arroyo toads are present in Santa Ysabel Creek and probably in other parts of the drainage as well (Dave Bacon, Cleveland National Forest, *in litt.* 1997). Although Lake Sutherland and Lake Hodges eliminated some of the historical arroyo toad habitat in the middle and upper parts of the basin, extensive stretches remain along the above creeks. Much of the available arroyo toad habitat is on private lands except for the Pamo and San Pasqual Valleys, which are owned by the City of San Diego. All of these locations currently are impacted by introduced plants and animals, livestock grazing, water diversions, agricultural activities and OHV use, and threatened by proposed urban development. The area needs further surveys to document the current extent of arroyo toad populations.

16) San Diego River Basin, San Diego County:

Arroyo toads were discovered initially in the San Diego River Basin at Lakeside on May 14, 1923, when a California Academy of Sciences expedition collected a single specimen (CAS 58080). During the next 2 decades, arroyo toads were found in San Vicente Creek (SDSNH 13805-13821, 14345-14352) and at El Capitan (SDSNH 21295-21299). Both locations now are inundated by reservoirs that have eliminated a portion of the historic arroyo toad habitat in the basin. Arroyo toads are present in the San Diego River above El Capitan Lake, at least to the mouth of Cedar Creek (J. Stephenson, pers. comm. 1997), and above San Vicente Reservoir (Figure 8). The size of the adult population is unknown. Arroyo toads probably are present in other streams (such as Conejo and King Creeks) within the drainage on the Capitan Grande Indian Reservation. Current impacts to the population include introduced aquatic predators, livestock grazing, OHVs, and recreational activities.

17) Sweetwater River Basin, San Diego County:

Arroyo toads first were discovered in the Sweetwater River near Dehesa during June, 1930, when a series of 10 specimens was collected by L. M. Klauber (CAS-SU 2601-2610) (Figure 8). Since then, arroyo toads have been collected and observed on the main Sweetwater River east of Loveland Reservoir and in Cuyamaca State Park (Jennings, unpubl. data), as well as Viejas Valley Creek (Campbell et al. 1996). Although Sweetwater Reservoir and Loveland Reservoir eliminated some of the historic habitat for arroyo toads within the drainage, arroyo toads are still common upstream from Loveland Reservoir and in Cuyamaca State Park, and between Sweetwater Reservoir and Loveland Reservoir. The area of current arroyo toad habitat is managed primarily by the Cleveland National Forest and the California Department of Parks and Recreation, and the Sweetwater Authority (water district) with a few private inholdings. California Department of Fish and Game manages an ecological preserve, Sloan Canyon, which harbors arroyo toads within the drainage. The status of the Viejas Creek arroyo toad population, within the Viejas Indian Reservation, is currently unknown. Arroyo toads at all sites within the drainage are affected by introduced plants and animals and recreational activities.

18) Otay River Basin, San Diego County:

Arroyo toads initially were discovered in the Otay River Basin on April 14, 1930, when F. E. Walker collected a series of five specimens on Dulzura Creek at Dulzura, San Diego County (SDSNH 13358-13362) (Figure 8). Arroyo toads probably are present within the drainage, although Upper and Lower Otay lakes, which were constructed before World War II, have eliminated some habitat. This population is entirely on private lands and currently is impacted by livestock grazing, introduced aquatic predators (especially fishes, bullfrogs, and African clawed frogs (*Xenopus laevis*)), introduced plants, sand and gravel mining, recreational activities, and OHVs.

19) San Felipe Creek Basin, San Diego County:

William Edward Duellman observed arroyo toads at the "Country Club at Borrego", San Diego County (L. M. Klauber, unpubl. field notes, July 25, 1950) (Figure 8). This record should be verified with field surveys of the Borrego Springs area. Surveys should be conducted in Borrego Palm Canyon, Banner

Creek and Coyote Creek, also.

20) Vallecitos Creek Basin, San Diego County:

There is a single record for the Vallecitos Creek Basin, consisting of three tadpoles collected on April 12, 1954, by Robert C. Stebbins, 16 kilometers (10 miles) southeast of the Vallecito Stage Station, San Diego County (MVZ 61061) (Figure 8). The status of this population is currently unknown and should be verified.

21) Tijuana River Basin, San Diego County and Baja California del Norte:

Arroyo toads were discovered initially in the Tijuana River Basin on May 12, 1923, when a single specimen was collected at Campo (along Campo Creek) by a California Academy of Sciences expedition (CAS 57897) (Figure 8). Since then, arroyo toads have been found in several drainages in the basin including Pine Valley Creek, Noble Creek, Cottonwood Creek, Kitchen Creek, Potrero Creek, Scove Canyon, and Morena Creek. Although Barrett Lake and Lake Morena have eliminated some of the historic arroyo toad habitat, arroyo toads are still very common in Cottonwood Creek above Lake Morena and in Pine Valley Creek. Today, the remaining arroyo toad habitat is threatened by development of private lands, and affected by water diversions, livestock grazing on private lands, roads across streams (such as at Pine Valley), OHVs, recreational activities, Border Patrol activities, and introduced aquatic predators. Because of the large number of potential arroyo toad streams within the basin, many of the creeks need to be surveyed for potential arroyo toad habitat and toads. The status of the arroyo toad in Mexico is unknown.

22) Pinto Wash Basin, Imperial County:

A population of 50 juvenile arroyo toads was discovered in the Pinto Wash Basin, Imperial County, by Jerrold J. Feldner during May, 1992 (Campbell et al. 1996). The site is at the base of the canyon at about 153 meters (500 feet), near the San Diego-Imperial County line on the Jacomba (In-Ko-Pah Mountains) Wilderness Study Area, managed by the Bureau of Land Management (Figure 8). The amount of arroyo toad habitat is unknown. Current threats include OHV use and travel by illegal immigrants.

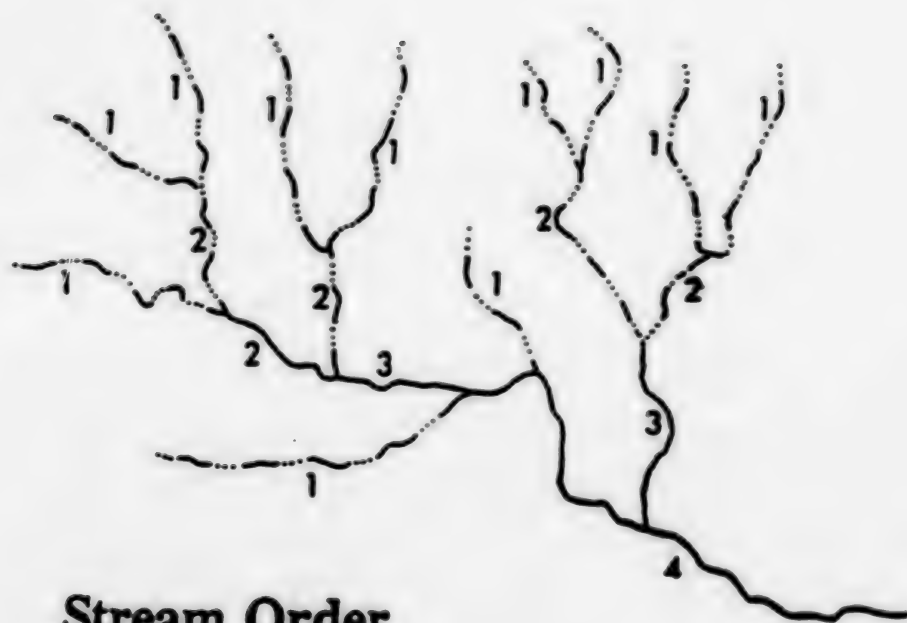
Life History and Ecology

For breeding purposes, the arroyo toad is specialized for riparian habitats that are disturbed naturally on a regular basis, primarily by flooding. This specialization makes their life history and ecological traits different from the typical *Bufo* pattern associated with other toad species, which often use ponds and other standing water rather than stream and river systems, in the western United States (Sweet 1992). The following discussion is adapted from Sweet (1992), Jennings and Hayes (1994), and Campbell et al. (1996).

In the northern portion of the range, arroyo toads are found in foothill canyons and intermountain valleys where medium- to large-sized rivers are bordered closely by low hills, riverbed gradients are low, and the surface stream flows frequently pool or are intermittent for at least a few months of the year (Miller and Miller 1936, Stebbins 1951, Sweet 1992). In general, this kind of habitat is described as Upper Sonoran (Myers 1930, Miller and Miller 1936, Sanders 1950). In southern California (central portion of the range of the arroyo toad), the species also occurs on the coastal plain.

For breeding, adult arroyo toads use open sites such as overflow pools, old flood channels, and pools with shallow margins on streams that, in the northern portion of the range, are third to sixth order (Sweet 1992) (Figure 9). In the central portion of the range, toads are found on first to fifth order streams. Such habitats rarely have closed canopies over the lower banks of the stream channel due to regular flood events. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads because of lower water and soil temperatures and poor algal mat development (Sweet 1992). Episodic flooding is critical to keep the low stream terraces relatively vegetation free and the soils friable enough for juvenile and adult toads to create burrows (Jennings and Hayes 1994).

Shallow pools with clear water averaging less than 30 centimeters (12 inches) deep are favored by adults for breeding (Sweet 1992, 1993). Breeding sites generally have flow rates less than 5 centimeters per second (0.2 foot per second) and bottoms composed of sand or well-sorted fine gravel, although a significant component of large gravel or cobble may be present. Areas that are used by juveniles consist primarily of sand or fine gravel bars with varying amounts of



Stream Order

Figure 9. Concept of stream order. The smallest tributaries are first-order streams; two combine to form a second-order stream, and two second-order streams combine to form a third-order stream, etc. (from Sweet 1992).

large gravel or cobble with adjacent stable sandy terraces and oak flats. Areas that are damp and contain some (less than 10 percent) vegetative cover such as American brooklime (*Veronica americana*) are favored by juvenile toads as these locations possess the refuge and thermal characteristics required for juvenile survival and rapid growth (Sweet 1992). Bare sand and gravel bars may support large numbers of juvenile toads, but survivorship usually is reduced due to high levels of predation (Sweet 1992).

The adjacent sandy terraces are covered with brush and trees such as mulefat (*Baccharis* spp.), California sycamore (*Platanus racemosa*), cottonwoods (*Populus* spp.), coast live oak (*Quercus agrifolia*), and willow (*Salix* spp.). The understory of stream terraces may consist of scattered short grasses, forbs, and leaf litter, or have no vegetation at all. For foraging, subadult and adult arroyo toads often utilize the soil around the drip lines of oak trees. These areas lack vegetation, yet have appropriate levels of prey (Sweet 1992). When active at night, toads often can be observed near ant trails feeding on passing ants and other prey. Substantial areas of fine sand, into which adult toads burrow, must be present. However, such habitats can be interspersed with gravel or cobble deposits.

Adult toads may range widely into the surrounding uplands, commonly up to 0.5 kilometer (0.3 mile) and as much as 1.3 kilometers (0.8 mile) from the stream (D. C. Holland, pers. comm. 1997). The uplands are often coastal sage scrub, chaparral, grassland, or oak woodland. Little is known currently about overwintering habitats and threats to adult toads during the nonbreeding season. Factors influencing survival between breeding seasons may include dessication, starvation, predation by native and introduced species, and activities that disturb nonbreeding habitats.

Adult arroyo toads begin breeding in late March in the northern portion of the range (Sweet 1992) and as early as January in the coastal areas of southern California (D. C. Holland, *in litt.* 1997). Breeding may continue into early July depending on when individual females reach reproductive condition and when the males stop calling (Sweet 1992). Males usually begin calling when water temperatures reach 14° Celsius (57° Fahrenheit) and may breed with several

females during the course of the season (Sweet 1992, Jennings, unpubl. data). Calling activity generally begins within 1 hour after sunset, with the receptive females seeking out calling males based on the size of the male and the sound of his call (Sweet 1992, 1993). The males usually call at the edge of pools in shallow water less than 5 centimeters (2 inches) deep, although they may call from sandbars out of the water (D. C. Holland, *in litt.* 1997), and are particularly susceptible to predation at this time (Sweet 1992). Amplexus (embracing of the female by the male) and egg-laying generally occur at the site where the male was calling. However, in rare instances, the female may carry the male up to 1 meter (3.3 feet) away from his calling site (Sweet 1992). Female arroyo toads apparently release their entire clutch of 2,000-10,000 eggs as a single breeding effort and probably are unable to produce a second clutch during the mating season. If conditions are unsuitable, females may not obtain sufficient resources for egg production and will forgo breeding during that year. The eggs are laid on substrates of sand, gravel, cobble, or mud generally located away from vegetation in the shallow margins of the pool (Sweet 1992).

Embryos usually hatch in 4-6 days at water temperatures of 12-16° Celsius (54-59° Fahrenheit). Larvae may take 8-14 days to become free swimming depending on the water temperature (Sweet 1992). Larvae are solitary, excellent swimmers and, once mobile, distribute themselves randomly or evenly along the shallow bottom of the breeding pool. Mature larvae swim in short bursts, often remaining motionless for 1-4 minutes between movements (Sweet 1992).

The larval period for arroyo toads lasts about 65-85 days, depending on water temperatures (Sweet 1992). Larvae do not consume macroscopic vegetation, but are highly specialized foragers. They feed by inserting their heads in the substrate and ingesting loose organic material such as detritus, interstitial algae, bacteria, and diatoms (Sweet 1992, Jennings and Hayes 1994). For several days before metamorphosis, arroyo toad larvae cease feeding and aggregate in shallow water along the edges of gravel or sand bars, often under or along stranded algal mats. Metamorphosis may occur at any time between the beginning of June and beginning of September, depending on the time of breeding and water quality. Peak metamorphosis occurs from the end of June to mid-July in the northern part of the toad's range (Sweet 1992, 1993) and from late April to mid-May in

southern California (D. C. Holland, *in litt.* 1997). Most newly metamorphosed individuals are 12-15 millimeters (0.5-0.6 inch) in length, but may be as small as 10-11 millimeters (0.4 inch) in poor quality habitats or as large as 17 millimeters (0.7 inch) in high quality habitat. If conditions permit, juvenile arroyo toads remain along the margins of the breeding pools for up to 6 months (Sweet 1992; D. C. Holland, *in litt.* 1997).

Juvenile arroyo toads remain in the saturated substrate at the edges of breeding pools for 1-3 weeks. They often are exposed on the barren sand because they lack sufficient size to burrow into the substrate. During this period, many toads are lost due to predation unless they can find some cover such as cobble, algal mats, or pieces of debris to hide under (Sweet 1992). The juvenile toads are diurnal for the first 4-5 weeks (Cunningham 1962) and subsist largely on ants (*Liometopum occidentale*). On this diet and with the high substrate temperatures, the juvenile toads grow rapidly. Upon reaching a length of 16-17 millimeters (0.6-0.7 inch) they begin to create shallow burrows in loose sand and may move farther away from the pool onto sand and gravel bars with some vegetation (Sweet 1992).

Upon reaching lengths of 17-23 millimeters (0.7-0.9 inch), juvenile toads are able to dig burrows 2-5 centimeters (0.8-2.0 inches) deep and completely bury themselves in the sand (Sweet 1992). At this time, juvenile toads change to a nocturnal activity pattern and spend the daylight hours in their burrows (Cunningham 1962). At night, they forage for nocturnal ants and beetles. If the substrate is not friable enough, juvenile toads often disperse farther away from the breeding pool into nearby stands of willows and mulefat thickets. Suitable sandy habitat can be highly localized resulting in dense concentrations of juvenile toads. Such sites generally are well-shaded (Sweet 1992).

Upon reaching a size of 28-30 millimeters (1.1-1.2 inch) in about 8-9 weeks, juvenile arroyo toads begin to shift their behavior and disperse away from streamside habitat into nearby willows (Sweet 1992), although they may remain streamside until they reach sizes greater than 35 millimeters (1.4 inch) (D. C. Holland, *in litt.* 1997). The timing of dispersal, which may be delayed until October or November, is affected by local drying conditions and the presence of suitable microhabitat for burrowing. Juvenile toads may take refuge underground

within the riparian zone and disperse farther away following the dampening of stream terraces by fall and winter rains (Sweet 1992). Nocturnal activity is normal for adults and larger juveniles, but they occasionally may be observed during the day. Juvenile toads reach 30–40 millimeters (1.2–1.6 inches) and occasionally 50 millimeters (2.0 inches) by the fall of their natal year and do not begin growing again until the following spring (Sweet 1992).

Arroyo toads usually reach adulthood in 2 years for males and in 2–3 years, at lengths greater than 54 millimeters (2.1 inches), for females (Sweet 1992, 1993). However, males can reach adulthood at 1 year if conditions are excellent (Sweet 1993). Females generally average larger sizes than males. Data on longevity are largely unavailable, although age-size distributions indicate that many individuals live only about 5 years (Sweet 1992, 1993). Longevity may vary with local conditions.

Little of the seasonal and annual movements or physiological ecology of adults is known, but recent data suggest that many subadults and some adult males move along streams as much as 0.8 kilometer (0.5 mile) and over 1.0 kilometer (0.6 mile) in a few cases (Sweet 1993). In San Diego County, adult arroyo toads regularly are found within 0.5 kilometer (0.3 mile) and up to 0.8 kilometer (0.5 mile) perpendicularly from streams (D. C. Holland, *in litt.* 1997). Extended movement away from streams range may be facilitated by microclimates wherein lower temperature and high humidity on foggy days in the spring and summer creates moist substrates in upland habitats where adult arroyo toads can subsist (D. C. Holland, *in litt.* 1997; S. S. Sweet, *in litt.* 1997). Recapture rates of marked individuals from one breeding season to the next have been as low as 15–50 percent (Sweet 1993; *in litt.* 1997). Insufficient data exist to characterize accurately overwintering activities and habitat use.

All life stages of the arroyo toad are susceptible to predation. Although not ingested, disturbance and fragmentation of egg strands by mallards (*Anas platyrhynchos*) can reduce hatching rates. Predators of larvae include giant water bugs (*Abedus indentatus*), two-striped and common garter snakes (*Thamnophis hammondi* and *T. sirtalis*), green sunfish, largemouth bass, fathead minnows, and bullfrogs. Predators of juveniles and adults include killdeer (*Charadrius*

vociferus), two-striped garter snakes, bullfrogs, green-backed herons (*Butorides striatus*), and great blue herons (*Ardea herodias*). Other potential predators of larvae, juvenile, or adults include black bullheads, prickly sculpins, African clawed frogs, western pond turtles (*Clemmys marmorata*), raccoons, opossums, American crows (*Corvus brachyrhynchos*), and common ravens (*C. corax*).

Reasons for Decline and Current Threats

The distribution of the arroyo toad appears to be restricted naturally as the result of specific habitat requirements for breeding and development. These natural restrictions, coupled with the small sizes of many arroyo toad populations, make them particularly vulnerable to the negative effects of human-induced changes to their habitats (Jennings and Hayes 1994). The following discussion of the reasons for arroyo toad declines and current threats to populations is modified from Sweet (1992, 1993) and Campbell et al. (1996).

There are several human-related activities that affect the hydrology of arroyo toad stream habitats and destroy or severely modify the dynamic nature of the riparian systems upon which arroyo toads depend for reproduction, development, and survival. Arroyo toad breeding habitat is created and maintained by the fluctuating hydrological, geological, and ecological processes operating in riparian ecosystems and the adjacent uplands within a Mediterranean climate. These riparian/wash habitats as well as adjacent upland habitats are essential for this species' survival. Periodic and unpredictable flooding that reworks stream channels and channel sediments and alters pool location and form, coupled with upper terrace stabilization by vegetation, is required to keep a stream segment suitable for all life stages of the arroyo toad. Human activities that affect water quality, influence the amount and timing of nonflood flows or frequency and intensity of floods, affect riparian plant communities, or alter sedimentation dynamics can reduce or eliminate the suitability of stream channels for arroyo toad breeding habitat. Degradation or loss of surrounding uplands reduces and eliminates foraging and overwintering habitat. The effects of such activities may not become apparent until many years later when the habitat finally becomes sufficiently degraded that arroyo toads can no longer reproduce and survive. These negative human activities include urbanization and agriculture within and adjacent to riparian habitats, dam building and the resulting reservoirs, water flow

manipulations, sand and gravel mining, suction dredge mining, road placement across and within stream terraces, livestock grazing, OHV use of roads and stream channels, the placement of campgrounds on stream terraces, and the use of stream channels and terraces for other recreational activities.

Besides physical habitat alteration, the stabilization of water flows and riparian vegetation also benefits a number of exotic species of plants and aquatic predators. These plants and animals, once they become established, tend to become widespread and build up large populations, which result in the loss of arroyo toads either indirectly through the degradation of habitat or directly through predation. The invasion of exotic plants can alter the fire regimes, leading to intense fires in the riparian zones. Some habitat changes may favor seemingly benign native species such as the California toad, which is able to survive in a variety of habitats. In habitats with small breeding populations of arroyo toads, increased densities of California toads can interfere with the calling activities of male arroyo toads (Awbrey 1972, Sweet 1992). In laboratory studies, juvenile California toads out-competed juvenile arroyo toads for prey (Sweet 1993).

In the following discussion, each of the above physical and biological factors is discussed in detail. Examples are provided where such factors have eliminated arroyo toad populations and where they currently threaten or impact remaining populations.

Agriculture, Mining, and Urban Development

Agriculture, mining, and urban development of stream terraces and adjacent uplands have destroyed large areas of arroyo toad habitat that formerly supported these animals. Examples losses due to urban development include Santa Paula Creek at Santa Paula, Ventura County; Chatsworth Drain in Canoga Park, Los Angeles County; the Big Tujunga River below Interstate 210, Los Angeles County; Santiago Creek, Orange County; and the lower San Luis Rey River, San Diego County. In addition to the outright destruction of the stream terraces, water is pumped out of the ground or diverted to support irrigation of farmlands and developments such as golf courses, and the natural streambeds are channelized and stabilized for flood control. These modifications can extend the negative

effects of streamside development both upstream and downstream, and may be particularly significant by destroying the arroyo toad's potential dispersal routes between closely-spaced tributary streams in a watershed (such as in San Mateo and San Onofre Creeks in San Diego County). Flood control activities may be conducted on a yearly basis (such as in lower San Juan Creek, Orange County) or during "emergency conditions" without permission from any regulatory agencies (including the Fish and Wildlife Service). Rip-rapping of stream banks may also negatively affect toads and habitat. Development and agricultural activities also alter runoff patterns, water quality, and sedimentation (Campbell et al. 1996), may provide habitat for and lead to the colonization and establishment of exotic plants and animals detrimental to arroyo toads (see the discussion below).

Suction dredge mining has become an important issue on Piru Creek on the Los Padres National Forest and Pine Creek on the Cleveland National Forest, although Piru Creek currently is withdrawn from mineral entry and mining activities. Suction dredge mining causes significant alteration of aquatic habitats and degradation of water quality. This form of placer mining often occurs in and adjacent to breeding pools, which are destroyed by filling with sediment and the physical rearrangement of the substrate. Such activities can increase siltation more than 1 kilometer (0.6 mile) downstream and can quickly kill many arroyo toad larvae. Siltation in arroyo toad breeding pools has been shown to asphyxiate eggs and newly hatched larvae (Sweet 1992). Suction dredge mining also can create deep pools in the stream that often hold water all year and become refugia for introduced predators of arroyo toad eggs and larvae (see the discussion below). Prospecting activities occurring on some streams, such as Little Horsethief Creek in the San Bernardino National Forest, including the digging of "glory holes" (pits up to 1.3 meters (4 feet) in diameter and 0.7 meter (2 feet) deep) in the stream beds and digging dry pits into the banks of the creeks, with subsequent sifting of the removed materials in the stream, building temporary dams to facilitate such activities, and the collateral use of OHVs, can have serious negative effects on arroyo toads and their habitat (S. A. Loe, *in litt.* 1997; Debby Hyde-Sato, San Bernardino National Forest, pers. comm. 1997). These activities also occur on private lands throughout southern California. Currently, the California Department of Fish and Game is preparing an environmental impact review of mining activities statewide.

Dams and Reservoirs

The creation of reservoirs has been responsible for the direct loss of a significant portion of the estimated historic range of the arroyo toad through the inundation of formerly suitable breeding and adjacent upland habitats (Jennings and Hayes 1994). There are at least 25 impoundments, discussed in the distribution section, within the current range of the arroyo toad that have inundated over 200 kilometers (124 miles) of suitable breeding habitat, as well as adjacent overwintering habitat. Groundwater pumping for agricultural and urban use also has reduced flows in many creeks and rivers on the coastal plain, adding to the negative impacts discussed below. Introduced beaver (*Castor canadensis*) also build dams, which may lead to increased water levels in arroyo toad breeding pools, making them unsuitable. Similarly, small temporary dams built by swimmers and miners or prospectors may alter pools sufficiently to cause reduction or elimination of breeding success in some areas.

Besides direct habitat losses through inundation, reservoirs regulate water flows, which affects the quality of arroyo toad habitat downstream by altering stream hydrology. Alterations include halting the scouring and deposition processes necessary to produce and maintain arroyo toad breeding pools and open terrace structures. Sediment is trapped above the dam, which can render long stretches downstream unsuitable for breeding and rearing habitat as the fine sands are stripped away. Prime examples of this are downstream from Gibraltar Reservoir on the Santa Ynez River, Pyramid Lake on Piru Creek, El Capitan Lake on the San Diego River, and Lake Morena on Cottonwood Creek. Restriction or elimination of flow also reduces summer water levels resulting in premature drying of breeding pools and the failure of arroyo toad reproductive efforts. Releases of surplus water and unseasonal releases disrupt the natural processes that produce required pool and terrace habitat and alter water depth and temperature. Unseasonal releases may prevent successful reproduction or recruitment by altering breeding pool characteristics or by washing away arroyo toad eggs or larvae. Examples of the latter have occurred on Piru Creek in Ventura County and Cottonwood Creek in San Diego County (Sweet 1992, Campbell et al. 1996).

Persistent releases throughout the normal dry season can also cause vegetative changes by encouraging the growth of riparian species, some native (e.g., willow, sycamore, *Typha* spp.) and some introduced (e.g., tamarisk and giant reed), in low frequency flood zones. This growth stabilizes the banks, deepens channels beyond a depth suitable for breeding pools, and shades the water, thus lowering water temperatures below the level required for larval growth and survival. When floods do occur in areas where giant reed exists, that species can spread very quickly as root masses are transported by the high water. Reservoir releases also maintain introduced aquatic predators (see discussion below). Virtually all known current arroyo toad populations downstream from reservoirs are affected or threatened by these factors.

Reservoirs also may act as barriers to instream movements of any surviving arroyo toad populations. If arroyo toads survive the construction and filling of the reservoir, then the individuals of a formerly interconnected population that were scattered along the drainage may be isolated from one another in major tributaries upstream of the reservoir and in the main channel downstream from the dam (Jennings and Hayes 1994). Due to the inherently dynamic and patchy nature of arroyo toad habitat, individuals may have moved up or downstream as conditions changed. Such movements likely are precluded by dam building, reservoir filling, and subsequent alteration of flow regimes. These limitations greatly increase the chance of extinction of the remaining arroyo toad population through random naturally occurring events such as fires, floods, and drought, as well as increased predation of larval toads from introduced aquatic predators that thrive in reservoirs and downstream channels (see the discussion below). The isolated remnants of the population may be precluded from recolonizing any part of the remaining habitats that lost arroyo toads (Campbell et al. 1996). This logic follows the theory of island biogeography, which states that small isolated populations are much more likely candidates for extirpation than populations (large or small) that are interconnected with one another (MacArthur and Wilson 1963).

Roads

Both paved and unpaved roads can have negative effects on arroyo toads if the

roads are placed on the stream terraces close to arroyo toad breeding habitats. Although arroyo toads crossing or foraging on paved roads are subject to high mortality at times (D. C. Holland, *in litt.* 1997), the loss of arroyo toads to traffic is particularly apparent on unpaved dirt roads where toads congregate at night to feed. On dirt roads in arroyo habitat (such as on the Los Padres and Cleveland National Forests), many subadult and adult toads can be killed by even one or a few vehicles. Roads are especially a problem in campgrounds near arroyo toad breeding sites, where traffic at night can result in a significant loss of adult toads, especially on holiday weekends or during hunting seasons when campgrounds continue to have high levels of traffic despite all campsites being filled. Toads also burrow into sandy roadbeds during the day, when they also may be crushed by vehicular and foot traffic (Nancy Sandburg, Los Padres NF, pers. comm. 1997; Sweet, *in litt.* 1997).

The problem of roads is not limited to private lands and National Forests. On Camp Pendleton, San Diego County, and Fort Hunter Liggett, Monterey County, roads on stream terraces and stream crossings are utilized by military vehicles, often during maneuvers or training sessions at various times of the day and night and throughout the year. These activities can lead to high mortalities of toads within areas of arroyo toad habitat (D. C. Holland, pers. comm. 1997). Methods to avoid these negative effects on toads include conducting vehicular traffic and training sessions in nontoad habitat and replacing channel culverts with appropriate stream crossings. Roadside toad fences and safe road crossings near arroyo toad breeding habitat may reduce mortality.

Livestock Grazing

Grazing by livestock affects arroyo toads directly and indirectly through impacts on habitat features (Sweet 1992, 1993). Livestock can trample egg clutches, larvae, and metamorphs in breeding pools, and juveniles and adult toads may be crushed as livestock walk through alluvial terraces. These impacts can become pronounced as livestock may also concentrate in riparian zones in large numbers after fires destroy upslope vegetation (M. Freel, *in litt.* 1997). However, as the upslope vegetation recovers, cattle will move back into those areas (D. Bacon, *in litt.* 1997). Sand bars and terrace habitats often are altered by the action of livestock herds, creating habitat on gravel bars that is unamenable for juvenile

arroyo toads. The increase in surface area caused by churning of the substrate may cause premature drying of breeding pools by increasing evaporation rates on the bars and subsequent wicking of water from the pools (Sweet, *in litt.* 1997). Grazing may change the stream morphology by altering erosion and flow processes (Campbell et al. 1996). Excessive grazing on upstream slopes can increase siltation, degrading water quality downstream and negatively affecting arroyo toad reproduction. Livestock grazing in the riparian habitats used by arroyo toads occurs primarily on private lands in Orange county (e.g., San Juan, Gabino, La Paz, Cristianitos, and Talega Creeks) and San Diego County (e.g., Witch, Temescal and Guejito Creeks), but also occurs on the Los Padres National Forest (lower Piru Creek and Agua Blanca Creek). Much of the riparian habitat within the Cleveland National Forest, including known breeding localities, has been excluded from grazing. Grazing on Fort Hunter Liggett was halted in 1991 due to drought conditions. In 1996, arroyo toads were discovered at two locations approximately 8 kilometers (5 miles) apart on the San Antonio River (U.S. Army Reserve Command 1996). In 1997, arroyo toads were found at about a dozen locations along approximately 28 kilometers (17 miles) of the river (H. Hormann, *in litt.* 1997). It has been suggested that the cessation of grazing along the river was a significant factor in the recovery and expansion of the arroyo toad population (U.S. Army Reserve Command 1996, U. S. Fish and Wildlife Service 1997).

Recreational Activities

Use of arroyo toad habitat by OHVs is incompatible with the species survival due to direct mortality and degradation of habitat through erosion, siltation, soil compaction, and possibly through hydrocarbon pollution (Sweet 1992). Tire tracks and ruts can isolate or drain portions of pools used as breeding or foraging areas, decreasing survival of eggs and tadpoles (Sweet, *in litt.* 1997). The amount of OHV use in some areas can be extremely heavy and may result in the extirpation of local arroyo toad populations and other sensitive species. For instance, the OHV use of the Mojave River above Victorville and below the Mojave Forks Dam was probably the major factor in the near elimination of toads from that part of the drainage (Jennings and Hayes 1994). Sweet (1992, 1993) observed OHVs in arroyo toad breeding sites on the Los Padres National Forest that resulted in the deaths of arroyo toad egg clutches, larvae, and juveniles.

In the four southern California National Forests, campgrounds frequently are located on or near (within 50-100 meters (165-330 feet)) arroyo toad habitat (i.e. on the stream terrace; Sweet 1992). In the Los Padres National Forest, seven campgrounds are located in arroyo toad habitat. In the Angeles National Forest, four campgrounds are in arroyo toad habitat. In the San Bernardino National Forest, there are no campgrounds near known arroyo toad habitat. In the Cleveland National Forest, four campgrounds are in arroyo toad habitat. Use of these areas in the early summer when young toads are diurnal, essentially sedentary, and live on sand bars can lead to losses from trampling. Subadults and adults foraging at night in open campground areas and on access roads can be crushed by vehicular or foot traffic. Stream morphology can be altered by the building of small dams to create deeper pools for swimming and waterplay. Some toads may be collected or killed by recreationists, especially children (Jennings, unpubl. data), or by poachers intent on selling the animals. Collection of adult toads during breeding seasons may alter sex ratios, decreasing reproductive potential for some populations, or eliminate some populations. Light and noise pollution from campgrounds may cause a reduction in the calling rate of male arroyo toads (Sweet 1992, Jennings and Hayes 1994), potentially reducing reproductive effort. Because little is known currently about arroyo toad overwintering ecology, the effects of fall and winter use of campgrounds on stream terraces and in adjacent uplands is unknown.

Fishermen also pose a problem for larval and adult arroyo toads. Trampling and the disturbance of stream side gravels is likely to occur, since many fishermen in southern California fish for native or stocked trout (*Onchorynchus mykiss*) in streams during the breeding and larval development seasons, when eggs and larvae are present in pools and juveniles are vulnerable on open sand and gravel bars. The problem is exacerbated by fishermen walking along open gravel bars or in the shallow portions of the streams to access suitable fishing sites. Even a few trips up and down streamside gravel bars or pools can kill many toads (Sweet 1992). The problem is particularly apparent near campgrounds where individuals often walk back and forth from the stream to the campground several times a day and inadvertently kill toads with each trip. This problem is most apparent in heavily used areas that are convenient to public access. Such areas include Sespe Creek, Piru Creek, Castaic Creek, and Little Rock Creek. Hunters may have

similar effects in some areas. In general, people are attracted to and recreate within the open sandy areas of drainages and therefore come in conflict with arroyo toad breeding and development.

Introduced Plants and Animals

The introduction of aquatic predatory organisms that did not co-evolve with arroyo toads can cause substantial reductions in the size of extant arroyo toad populations and may have contributed to extirpation of some populations of the species (Jennings and Hayes 1994), such as along the upper Santa Ynez River where bullfrogs now are well established in former arroyo toad habitat. The introduction of aquatic species not native to southern California watercourses has been facilitated by construction of the California Aqueduct and other sources of interbasin transport. Currently, the California Aqueduct is linked directly to the Santa Ynez River, Santa Clara River, San Jacinto River, and Mojave River basins, and more connections are proposed. Predatory species, many of which have used the aqueduct to colonize these river basins, include green sunfish, largemouth bass, black bullhead, prickly sculpin, stocked rainbow trout, oriental gobies (*Tridentiger* spp.), red shiners (*Cyprinella lutrensis*), and crayfish. Several of these species have been shown to feed on arroyo toad larvae in laboratory trials (Sweet 1992), and could cause high larval mortality in arroyo toad breeding pools in the wild. They also tend to build up large populations in the artificial reservoirs that have been created in arroyo toad habitats. In many cases these populations extend from the reservoirs into the streams. These species could harbor disease organisms to which arroyo toads may be susceptible. In addition to these predators, the introduced bullfrog and African clawed frog (which are aggressive colonizers) are present on many streams that support arroyo toad populations. The spread of African clawed frogs in southern California may also be increased unwittingly by the planting of mosquitofish by vector control agencies, due to the presence of clawed frog larvae in several mosquitofish source ponds in San Diego County (R. N. Fisher, pers. comm. 1997). Artificially sustained flow regimes and activities that create ponds (including the introduction of beaver into central and southern coastal montane regions) make habitat more suitable for bullfrogs and African clawed frogs than for arroyo toads (Sweet 1992; Jennings, unpubl. data). Adult bullfrogs have been observed to eat juvenile and adult arroyo toads in the wild (Sweet 1993) and they are suspected of causing the localized decline of

several native amphibians in California (Jennings and Hayes 1994).

In addition to the above aquatic predators, there also are introduced terrestrial predators such as the opossum that have built up large populations in southern California, including some in areas still inhabited by arroyo toads. For example, opossum tracks are very common along the Santiago, Cristianitos, Gabino, La Paz and San Juan Creek drainages in Orange County and they probably eat arroyo toads if the opportunity arises (P. H. Bloom, *in litt.* 1997). The development of rural areas also increases the amount of garbage available to native animals that thrive in such situations. These include American crows, common ravens and raccoons, which may become very efficient at feeding on arroyo toads. Although native, raccoons are often relocated by animal damage control personnel. Large numbers released in limited areas over a short time span can have a serious detrimental effect on arroyo toads and other sensitive species.

An additional negative effect of development and human-produced garbage is the establishment of introduced Argentine ants (*Linepithema humile*, formerly *Iridomyrmex humilis*). It is not known if the ants are a direct threat to arroyo toads, but they colonize disturbed areas and build up large colonies. In doing so, they also eliminate the native ant fauna that is a major food source of the arroyo toad (Ward 1987, Holway 1995). Argentine ants are well established in some arroyo toad habitats such as the lower portion of the Santa Margarita River (Jennings, unpubl. data).

In addition to the introduced predators, introduced plants can have a negative effect on arroyo toads and their habitat. Tamarisk and giant reed colonize newly created flood terraces and soon become an impenetrable mass of vegetation. They also stabilize stream terraces and help to deepen flood channels, resulting in habitat unsuitable for arroyo toads. Dense stands may have increased rates of evapotranspiration over native vegetation, increasing the rate at which breeding pools dry. Such stands may also alter fire regimes within the riparian zones. The spread of introduced plants is a major threat to arroyo toad populations on Castaic Creek in Los Angeles County, and San Onofre and San Mateo Creeks, the lower Santa Margarita River, and the San Luis Rey River in San Diego County.

Other introduced plants that make riparian and upland habitats unsuitable for arroyo toads include white sweetclover (*Melilotus alba*) and iceplant (*Mesembryanthemum* spp.) (S. S. Sweet, pers. comm. 1997). White sweet-clover becomes so well established that it often acts as a debris trap covering most or all of the available sandy stream terraces required by toads for burrowing. Iceplant tends to take over large areas of upland coastal sage, grasslands, and chaparral, eliminating the native flora over time. It creates dense thickets of foliage that arroyo toads cannot get through or use for cover. Ice plant also supports very few native invertebrates, the potential food items of arroyo toads.

The problem of introduced plants and animals negatively affecting arroyo toads is becoming very serious. Almost all the known sites where arroyo toads are present have at least one introduced plant or animal, and many have several. About 98 percent of the known arroyo toad habitat on Camp Pendleton, San Diego County, has established populations of introduced fishes, bullfrogs, tararisk, and giant reed (D. C. Holland, pers. comm. 1997). The situation will continue to degrade in favor of the exotics unless methods can be found to control the growth and colonization of these species. The problem is particularly acute with the introduced plants at lower elevations in Orange and San Diego counties.

Natural and Unnatural Disturbances

Because arroyo toad habitats have been and are being affected by human activities, small isolated populations are at risk due to natural disturbances such as extended droughts, fires, and rare large floods. Drought, especially of prolonged duration, results in a temporary loss of suitable habitat, particularly breeding pools. The number and intensity of floods decreases during droughts, limiting the formation and filling of breeding pools in flood channels. Adult and juvenile toads are affected directly by droughts when suitable foraging conditions occur for shorter time periods. Female toads in particular may be adversely affected by drought. Two months of intensive feeding effort are required for vitellogenesis (yolk production) (Sweet 1992). Under drought conditions, females may not be able to obtain adequate energy reserves for egg production before the male toads cease calling, leading to reproductive failure for that season. If the life span of the arroyo toad averages 5 years or less (Sweet 1992, 1993), prolonged droughts could prevent successful breeding or recruitment long enough to extirpate some

populations.

Large floods are rare but can affect arroyo toads by excessive scouring and sedimentation, washing out adult habitat on upper alluvial benches, altering the quality of breeding pools and juvenile arroyo toad habitat. Unseasonal floods can wipe out an entire watershed's reproductive effort by scouring eggs or larvae out of breeding pools, or depositing silt in downstream breeding pools. The impacts are compounded by human activities such as water releases and flood control structures (see the discussion above).

Periodic fires affect arroyo toads by causing direct mortality and destruction of streamside or terrace vegetation. Because riparian zones have been affected by fire suppression, the invasion of exotic plant species and increased human activities, fires now tend to be more frequent, especially near established campgrounds. This altered regime may have negative impacts on the stability of breeding pools, sand and gravel bars, and streamside terraces. Altered fire regimes in the surrounding uplands may affect the suitability of soils for burrowing and the capacity of vegetation to provide cover for migrating toads as well as their prey base. In 1991, the Lions Fire on upper Sespe Creek of the Los Padres National Forest destroyed habitat for the single largest extant population of arroyo toads known at that time and the only population known to have successfully reproduced in the northern part of its range from 1989 to 1991 (Sweet 1992, 1993). The result of the fire was extensive erosion from the terraces, filling of breeding pools, and loss of arroyo toad reproduction at least through 1995 (S. S. Sweet, *in litt.* 1997).

Conservation Measures

Because the arroyo toad was listed under the Endangered Species Act only recently (U.S. Fish and Wildlife Service 1994), relatively few conservation efforts were conducted before the 1990s. The earliest efforts to determine the life history and threats to arroyo toads on the Los Padres National Forest were begun in 1980 and were funded privately, by the University of California, Santa Barbara, and by the U.S. Forest Service (Sweet 1992, 1993). Additional studies have been funded by the Fish and Wildlife Service and the U.S. Geological Survey.

The California Department of Fish and Game funded a project to determine the overall status of candidate species of amphibians and reptiles in the State, including the arroyo toad (Jennings and Hayes 1994). This study helped determine the overall historic range and current status of arroyo toad populations in southern California through 1994. The California Department of Fish and Game also funded surveys for arroyo toads in potential habitats during the summers of 1992 and 1993. Those efforts located arroyo toad populations in Castaic Creek, San Juan Creek, and the Santa Margarita River (Campbell et al. 1996).

The Fish and Wildlife Service funded the former National Biological Service (now the Biological Resources Division of the U.S. Geological Survey) to review the available literature on arroyo toads and provide an accessible summary reference for land managers and planners concerned with potential impacts to the arroyo toad (Campbell et al. 1996).

In addition to the arroyo toad studies on the Los Padres National Forest, there were surveys of known arroyo toad habitats on the Angeles National Forest, San Bernardino National Forest, Cleveland National Forest (1992-1997), Fort Hunter Liggett (1996-1997) and Camp Pendleton (1995-1997). The Camp Pendleton surveys were especially important in documenting differences in the central portion of the range in habitat use (smaller streams and deeper canyons), activity patterns (breeding as early as January, juveniles remaining at streamside longer), and movements of toads (may move further from streams) (D. Holland, *in litt.* 1997) from those parameters where arroyo toads have been studied intensively in Santa Barbara and Ventura counties (in the northern part of the species' range; Sweet 1992, 1993).

The Fish and Wildlife Service has conducted numerous consultations with the Army Corps of Engineers, Department of the Army, Marine Corps, and the Forest Service across the range of the arroyo toad. These consultations resulted in measures to avoid or reduce impacts to the arroyo toad. Resulting conservation measures include bullfrog reduction or eradication, exotic plant removal, habitat restoration and enhancement, cattle exclusion, road and OHV trail closures or relocations, campground and recreation area closures and relocations, road

crossing type monitoring, upland habitat preservation, and project changes for avoidance of breeding habitat or season.

Camp Pendleton completed a consultation that included ongoing training, maintenance, and specific projects on October 30, 1995 (U.S. Fish and Wildlife Service 1995). This consultation addressed the impacts of these activities only on riparian and estuarine/beach ecosystems. One of the main goals of the consultation is to maintain the natural processes of the wetland habitats. Instructions within the biological opinion focused on avoidance, minimization, and mitigation measures. For all unavoidable impacts to these ecosystems, the primary mitigation measure is the removal of giant reed (*Arundo donax*). Camp Pendleton is currently in the early stages of a programmatic consultation with the Fish and Wildlife Service involving species that use upland habitat, including the arroyo toad.

The four southern California National Forests are currently planning for multispecies conservation for forest and woodland species and habitats, including the arroyo toad. Recent coordination between the Fish and Wildlife Service, the Forest Service (Los Padres), the California Department of Water Resources, and California Department of Fish and Game have resulted in releases from Pyramid Dam on Piru Creek that more closely mimic natural flows in lower Piru Creek. The modified releases have benefitted arroyo toads in lower Piru Creek (S. S. Sweet, pers. comm. 1997). Piru Creek also has been withdrawn from mineral entry, a strategy that could be used to protect arroyo toads and other sensitive species on additional drainages subject to mining and prospecting activities.

The San Bernardino National Forest has instituted programs to reduce or eliminate OHV use on the Mojave River, Deep Creek, and Little Horsethief Creek, to control livestock use of the Deep Creek drainage, and to control prospecting activities in Little Horsethief Creek. Cleveland National Forest has consulted with the Fish and Wildlife Service regarding grazing on their lands.

Arroyo toads currently are being addressed in the Fish and Wildlife Service's and the California Department of Fish and Game's Natural Community Conservation Planning (NCCP) process. Specifically, they are included in the Orange County

Central/Coastal Subregion NCCP/Habitat Conservation Plan (HCP) and the San Diego County Multi-Species Conservation Plan (MSCP).

The arroyo toad has been identified as a "conditionally covered" species by the Orange County Central/Coastal Subregion NCCP/HCP. "Conditional coverage" allows for projects to proceed within the Central/Coastal subregion that will impact "smaller (arroyo toad) populations (including the lower Limestone Canyon population (unconfirmed)), reintroduced populations, or populations that have expanded due to NCCP reserve management" (pg. II-231, Orange County Central/Coastal NCCP/HCP). However, such projects are still required to be consistent with a mitigation plan that involves minimization of impacts and appropriate feasible protections, and/or arroyo toad relocation coupled with compensatory habitat management and enhancement that maintains the carrying capacity of toads at the relocation site. Habitat that supports a major arroyo toad population that plays an essential role in the distribution of the arroyo toad in this subregion is not covered.

Two NCCP subregional plans are underway in western San Diego County. The northwestern planning effort, the Multiple Habitat Conservation Plan (MHCP), is in the planning process. The southwestern plan, the Multiple Species Conservation Plan (MSCP), proposes to conserve the known locations of the arroyo toad within Santa Ysabel Creek in San Pasqual Valley, San Vicente Creek above San Vicente Reservoir, Sweetwater River, the Otay River, and Cottonwood Creek in Marron Valley. Area specific management directives for these plans must address the maintenance of the arroyo toad through protection and maintenance of sufficient suitable low gradient sandy stream habitat to meet breeding requirements, preservation of sheltering and foraging habitat within 1 kilometer (0.6 mile) of occupied breeding habitat within preserved lands, control of nonnative predators, and measures to control human impacts within designated preserves.

Recovery Strategy

The recovery strategy for the arroyo toad is focused on providing sufficient breeding and upland habitat to maintain self-sustaining populations of arroyo toads throughout the historic range of the species in California, and minimizing or

eliminating impacts and threats to arroyo toad populations. This plan describes specific tasks necessary to maintain healthy aquatic, riparian, and adjacent upland ecosystems that provide habitat for arroyo toads.

The recovery strategy for the arroyo toad consists of five parts: 1) stabilize and maintain populations throughout the range of the arroyo toad in California by protecting sufficient breeding and nonbreeding habitat, 2) monitor the status of existing populations to ensure recovery actions are successful, 3) identify and secure additional suitable arroyo toad habitat and populations, 4) conduct research to determine the population dynamics and ecology of the species to guide management efforts and determine the best methods for reducing threats, and 5) develop and implement an outreach program.

In-stream and riparian habitats that support breeding of arroyo toads, as well as upland habitats that provide foraging and overwintering habitat, need to be managed to maintain and enhance existing populations throughout the range of the arroyo toad in California. Management actions may include altering water control activities, recreational use patterns, and livestock grazing, and may also include reducing or eliminating introduced plant and animal populations. In addition, ecosystem based conservation plans need to be developed for those portions of the river basins not on Federal lands. Populations should be monitored to assess the effectiveness of the management actions.

Potential arroyo toad habitat should be surveyed to locate currently unknown arroyo toad populations. Appropriate management of newly discovered arroyo toad populations and habitats should be implemented as soon as possible after discovery.

Research to determine differences in life history traits and ecology of the arroyo toad throughout its range is necessary to guide management efforts, conservation agreement and plan development, and to evaluate the impacts of human activities on arroyo toad populations. Research to determine the criteria for arroyo toad presence in drainages can provide information necessary to guide habitat enhancement and restoration efforts.

Development of an outreach program will garner support for the Fish and Wildlife Service's recovery efforts and reduce anthropogenic effects on arroyo toad habitats and populations.

An important component of the recovery strategy for the arroyo toad is adaptive management. This plan is based upon the best available information. Crucial to delisting is implementation of a monitoring program to assess the success of management actions. Based on the results of implementation tasks, management needs to be adaptive to incorporate only those tasks that are successful. Tasks that are not successful should be modified or redesigned.

PART II RECOVERY

Objectives: This recovery plan defines two objectives: first, to recover the arroyo southwestern toad (arroyo toad) sufficiently to warrant reclassification to threatened status, and second, to recover the species sufficiently to warrant delisting.

Recovery Criteria: The arroyo toad will be considered for reclassification from endangered to threatened status when management plans have been approved and implemented on federally managed lands to provide for conserving, maintaining and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat; and when these measures are successful in maintaining a minimum of 19 self-sustaining populations of arroyo toads (minimum number of populations for each agency and locale are indicated in parentheses), including Fort Hunter Liggett Army Reserve Training Center (1), Camp Joseph H. Pendleton Marine Corps Base (2), Los Padres National Forest (4), Angeles National Forest (3), San Bernardino National Forest (1), Cleveland National Forest (7) and the Jacomba (In-Ko-Pah Mountains) Wilderness Study Area (1) managed by the Bureau of Land Management. Self-sustaining populations are those documented as having successful recruitment in 7 of 10 years of average to above average rainfall amounts with normal rainfall patterns.

Delisting of the arroyo toad will be considered when the genetic and phenotypic variation of the arroyo toad throughout its range in California is secured by maintaining 15 additional self-sustaining populations of arroyo toads on coastal plain, coastal slope, desert slope, and desert lands, including known populations outside of Federal jurisdiction on the Whitewater River, Riverside County; in the San Juan Creek basin, Orange County; Santa Margarita River basin, San Diego and Riverside Counties; and the San Luis Rey River, San Dieguito River/Santa Ysabel Creek, San Diego River, Sweetwater River, Otay River/Dulzura Creek, and Tijuana River basins in San Diego County.

Narrative

- 1 Populations should be secured by protecting, maintaining, restoring and enhancing breeding and upland habitats by conducting the following:**
 - 1.1 Develop and implement management plans that minimize or eliminate impacts to arroyo toads and their habitats on Federal lands (including Forest Service, Military Reservation, and Bureau of Land Management lands). Management plans may include tasks that:**
 - 1.1.1 Minimize or eliminate impacts to arroyo toads and their breeding habitat near campgrounds to prevent the killing or injury of all life stages of arroyo toads.**
 - 1.1.2 Annually close roads in or near arroyo toad breeding habitat during the spring and summer to prevent the killing of subadult and adult toads on roads.**
 - 1.1.3 Control mining and prospecting activities in drainages with arroyo toad populations to prevent habitat degradation, death of and injury to toads.**
 - 1.1.4 Control fishing activities in arroyo toad breeding habitats when arroyo toads are present in the stream channel and on the sand and gravel bars (late spring and summer). This control will help eliminate trampling of eggs, larvae, and juvenile toads in riparian areas when they are most vulnerable to such activities.**
 - 1.1.5 Monitor and remove exotic vegetation (iceplant, tamarisk, and giant reed) in affected drainages. Determine if the removal benefits arroyo toad populations.**
 - 1.1.6 Replace inadequate stream crossings on roads within arroyo toad habitats with appropriate crossings.**
 - 1.1.7 Reduce or eliminate livestock grazing in riparian zones known to have arroyo toad populations. This reduction will prevent the trampling of toads and degradation of their habitat.**
 - 1.1.7.1 Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on the**

- Los Padres National Forest.
 - 1.1.7.2 Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on the San Bernardino National Forest.
 - 1.1.7.3 Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on the Cleveland National Forest.
 - 1.1.7.4 Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Fort Hunter Liggett.
 - 1.1.7.5 Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Camp Pendleton.
 - 1.1.8 Identify and eliminate breeding sites (e.g., stock ponds, small reservoirs, etc.) of introduced fishes and aquatic predators such as bullfrogs near arroyo toad habitat, where feasible. Eliminate or control introduced species where already found. Prevent further introductions of nonnative aquatic animals into arroyo toad habitats. Work with mosquito abatement districts to prevent the introduction of African clawed frogs into arroyo toad habitats.
 - 1.2 With the assistance of nonfederal land management agencies and private landowners, reduce adverse effects to arroyo toads and their habitat through the establishment of conservation agreements, environmental easements, multi-species conservation plans, habitat conservation plans, and acquisition.
 - 1.3 Manage flows downstream from dams in drainages that have arroyo toad populations in a manner conducive to arroyo toad reproduction and survival and to the maintenance of arroyo toad habitat.
 - 1.3.1 Maintain a more compatible pattern of stream flows

- downstream from Jamieson Lake.
- 1.3.2 Maintain a more compatible pattern of stream flows downstream from Pyramid Lake.
- 1.3.3 Maintain a more compatible pattern of stream flows downstream from Castaic Lake.
- 1.3.4 Maintain a more compatible pattern of stream flows downstream from Lake Henshaw.
- 1.3.5 Maintain a more compatible pattern of stream flows downstream from Lake Sutherland.
- 1.3.6 Maintain a more compatible pattern of stream flows downstream from Lake Cuyamaca.
- 1.3.7 Maintain a more compatible pattern of stream flows downstream from El Capitan Reservoir.
- 1.3.8 Maintain a more compatible pattern of stream flows downstream from Loveland Reservoir.
- 1.3.9 Maintain a more compatible pattern of stream flows downstream from Barrett Lake.
- 1.3.10 Maintain a more compatible pattern of stream flows downstream from Morena Reservoir.
- 1.4 Coordinate the activities of the Border Patrol and other law enforcement agencies to reduce the negative effects to arroyo toad populations. Specific problems include driving in creeks, building roads on stream terraces, building fences, and using spotlights and floodlights in the drainages during the arroyo toad active season(s).
- 2 Monitor the status of the arroyo toad breeding populations to ensure recovery actions are achieving desired results.
 - 2.1 Develop a comprehensive arroyo toad monitoring protocol to provide sufficient baseline information on the status of each adult population.
 - 2.2 Conduct monitoring of the adult populations at least every other year for 12 years.
 - 2.3 Assess the results of population monitoring and management actions and modify management direction as necessary.

- 3 Identify and secure additional populations and suitable habitat throughout the range of the arroyo toad in California.
 - 3.1 Develop an arroyo toad survey protocol complete with a field card showing all life stages of the toad.
 - 3.2 Survey areas within the potential range of the arroyo toad for suitable habitat and presence or absence of arroyo toads.
 - 3.2.1 Upper Salinas River basin.
 - 3.2.1.1 Main Salinas River upstream from King City.
 - 3.2.1.2 San Antonio River.
 - 3.2.1.3 Nacimiento River.
 - 3.2.2 Cuyama River.
 - 3.2.2.1 Main Cuyama River above Twitchell Reservoir.
 - 3.2.2.2 Huasna Creek above Twitchell Reservoir
 - 3.2.3 Santa Ynez River basin.
 - 3.2.3.1 Cachuma Creek.
 - 3.2.3.2 Santa Cruz Creek.
 - 3.2.3.3 Horse Canyon.
 - 3.2.3.4 Redrock Canyon.
 - 3.2.4 Upper Santa Clara River basin.
 - 3.2.4.1 Elizabeth Creek upstream from Castaic Lake.
 - 3.2.4.2 San Francisquito Canyon drainages.
 - 3.2.4.3 Bouquet Canyon drainages.
 - 3.2.4.4 Mint Canyon drainages.
 - 3.2.5 Upper San Jacinto River basin.
 - 3.2.5.1 San Jacinto River upstream from Hemet.
 - 3.2.5.2 Bautista Creek.
 - 3.2.6 San Juan Creek basin.
 - 3.2.6.1 Arroyo Trabuco.
 - 3.2.6.2 Cañada Chiquita.
 - 3.2.6.3 Cañada Gobernadora.
 - 3.2.7 Santiago Creek Drainage.
 - 3.2.7.1 Fremont Canyon.

- 3.2.7.2 Black Star Canyon.
 - 3.2.7.3 Baker Canyon.
 - 3.2.7.4 Silverado Canyon.
 - 3.2.8 Temecula Creek above Vail Lake, Upper Santa Margarita River basin.
 - 3.2.9 San Luis Rey River basin.
 - 3.2.10 San Dieguito River / Santa Ysabel Creek basin.
 - 3.2.11 San Diego River basin.
 - 3.2.12 Sweetwater River basin.
 - 3.2.13 Otay River basin.
 - 3.2.14 Cottonwood Creek drainage basin.
 - 3.2.15 San Felipe Creek basin.
 - 3.2.16 Borrego Springs and Coyote Creek area.
 - 3.2.17 Vallecito Creek basin.
 - 3.2.18 Pinto Wash basin.
 - 3.3 Identify and implement necessary management actions for securing any additional populations found as a result of surveys or by other means.
- 4 Conduct research to determine ecology and population dynamics of the arroyo toad throughout its range in California and to determine the effects of human activities on arroyo toads and their habitat as needed to guide management efforts and determine the best methods for reducing threats. Incorporate new information into Tasks 1 and 2.
- 4.1 Determine and quantify differences in the life history and ecology of the arroyo toad relative to latitude and elevation.
 - 4.2 Quantify the ecological parameters for arroyo toad presence within drainages throughout the species range in California, including biotic and abiotic factors.
 - 4.3 Experimentally remove exotic aquatic species from arroyo toad habitats and determine which methods work and are feasible.
 - 4.4 Determine the best types of stream crossings and road barriers for protecting arroyo toads.
 - 4.5 Determine if arroyo toads are moving between drainages.
 - 4.6 Assess impacts of different grazing regimes on arroyo toads.
 - 4.7 Assess impacts of recreational activities on arroyo toads.

- 4.8 Collect tissue samples from known and new arroyo toad populations to determine genetic differences and similarities within and among populations.
- 5 Develop information and education programs. Public and agency support is essential to recovery of the arroyo toad. Information brochures should clearly explain the impacts to arroyo toads from introduced aquatic and terrestrial species, OHVs, fishing, camping, and other recreational uses of streambeds and riparian zones, livestock grazing, collection, dam construction and flow regulation, mining, and other activities. Brochures should detail actions that minimize adverse impacts to arroyo toads and highlight successful examples of mitigation and remediation.
 - 5.1 Develop educational brochures and make them available to agencies with regulatory jurisdiction over arroyo toad habitat and to users of lands on which arroyo toads occur.
 - 5.2 Provide educational programs for visitors to National Forests, and State and county parks where arroyo toads occur.

PART III
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PART IV IMPLEMENTATION SCHEDULE

The schedule that follows is a summary of actions and estimated costs for the arroyo toad recovery program. It is a guide to meet the objectives of the revised recovery plan as elaborated in Part II, Narrative Section. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies and, lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. It should be noted that the estimated monetary needs for some tasks remain to be determined and, therefore, Part III reflects the minimum estimated financial requirements for the recovery of the species.

Definitions and Acronyms Used in Implementation Schedule:

Priorities in column one of the following implementation schedule are assigned as follows:

- 1 = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- 2 = An action that must be taken to prevent a significant decline in species' population, habitat quality, or some other significant negative impact short of extinction.
- 3 = All other actions necessary to provide for full recovery of the species.

Key to Acronyms:

BLM	--	Bureau of Land Management
BP	--	California Border Patrol
BRD	--	Biological Resources Division, U.S. Geological Survey
CAS	--	California Academy of Sciences
CDFG	--	California Department of Fish and Game
CDPR	--	California Department of Parks and Recreation
CDWR	--	California Department of Water Resources

CPMCB	--	Camp Pendleton Marine Corps Base
CSD	--	City of San Diego
FHLMR	--	Fort Hunter Liggett Military Reservation
FNWA	--	Fallbrook Naval Weapons Annex
TBD	--	To Be Determined
TNC	--	The Nature Conservancy
USFS	--	U.S. Forest Service
USFWS	--	U.S. Fish and Wildlife Service
USMR	--	U.S. Military Reservations
VID	--	Vista Irrigation District

*Denotes lead agency.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1,000)					ANNUAL COSTS FY 2004 - 2010
						FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	
Need 1: Protect, maintain, and enhance breeding and upland habitats.											
2	111	Minimize or eliminate impacts to arroyo toads and their breeding habitat near campgrounds to prevent the killing or injury of all life stages of arroyo toads	Continuous	USFS	120	10	10	10	10	10	10
2	112	Annually close roads in or near arroyo toad breeding habitat during the spring and summer to prevent the killing of subadult and adult toads on roads	Continuous	USFS water districts	120	10	10	10	10	10	10
2	113	Control mining and prospecting activities in drainages with arroyo toad populations to prevent habitat degradation, death of and injury to toads	Ongoing	USFS	120	10	10	10	10	10	10
2	114	Control fishing activities in arroyo toad breeding habitats when arroyo toads are present in the stream channel on the sand and gravel bars	Continuous	CDFG*	12	1	1	1	1	1	1
2	115	Monitor and remove exotic vegetation where found. Determine if the removal benefits arroyo toads	Continuous	USFS, CPMCB	TBD	TBD	TBD	TBD	TBD	TBD	
				FNWA, CDFG	TBD	TBD	TBD	TBD	TBD	TBD	
2	116	Replace inadequate stream crossings on roads within known arroyo toad habitats with appropriate crossings	TBD	USFS*	TBD	TBD	TBD	TBD	TBD	TBD	
				USMR	TBD	TBD	TBD	TBD	TBD	TBD	
2	1171	Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Los Padres National Forest	3	USFS	60	20	20	20	0	0	
2	1172	Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on San Bernardino National Forest	3	USFS	60	20	20	20	0	0	
2	1173	Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Cleveland National Forest	3	USFS	60	20	20	20	0	0	

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1 000)					ANNUAL COSTS FY 2004 - 2010
						FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	
2	1174	Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Fort Hunter Liggett.	3	USFS	60	20	20	20	0	0	
2	1175	Develop and implement a livestock management plan to reduce or eliminate, as necessary, impacts to arroyo toads on Camp Pendleton.	3	USFS	60	20	20	20	0	0	
2	118	Identify and eliminate breeding sites of introduced fishes and aquatic predators near arroyo toad habitat, and control or eliminate exotic species.	5	CDFG*	20	4	4	4	4	4	
				USFS	20	4	4	4	4	4	
2	12	With the assistance of private landowners, reduce adverse effects to arroyo toad habitat through conservation agreements, environmental easements, multispecies and habitat conservation plans and/or acquisition.	Continuous	USFWS*	TBD	TBD	TBD	TBD	TBD	TBD	
				CDFG	TBD	TBD	TBD	TBD	TBD	TBD	
2	131	Maintain a more compatible pattern of stream flows downstream from Jamieson Lake.	Continuous	CDWR	12	1	1	1	1	1	1
2	132	Maintain a more compatible pattern of stream flows downstream from Pyramid Lake.	Continuous	CDWR	12	1	1	1	1	1	1
2	133	Maintain a more compatible pattern of stream flows downstream from Castaic Lake.	Continuous	CDWR	12	1	1	1	1	1	1
2	134	Maintain a more compatible pattern of stream flows downstream from Lake Henshaw.	Continuous	VID	12	1	1	1	1	1	1
2	135	Maintain a more compatible pattern of stream flows downstream from Lake Sutherland.	Continuous	CDWR	12	1	1	1	1	1	1
2	136	Maintain a more compatible pattern of stream flows downstream from Lake Cuyamaca.	Continuous	CDWR	12	1	1	1	1	1	1
2	137	Maintain a more compatible pattern of stream flows downstream from El Capitan Reservoir.	Continuous	CDWR	12	1	1	1	1	1	1

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1,000)					ANNUAL COSTS FY 2004 - 2010
						FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	
2	138	Maintain a more compatible pattern of stream flows downstream from Loveland Reservoir	Continuous	CDWR	12	1	1	1	1	1	1
2	139	Maintain a more compatible pattern of stream flows downstream from Barrett Lake	Continuous	CSD	12	1	1	1	1	1	1
2	1310	Maintain a more compatible pattern of stream flows downstream from Morena Reservoir	Continuous	CDWR	12	1	1	1	1	1	1
2	14	Coordinate with the Service regarding the activities of law enforcement agencies to reduce impacts to arroyo toads	Continuous	BP*	12	1	1	1	1	1	1
				USFWS	12	1	1	1	1	1	1
Need 1 Subtotal Cost:					856	151	151	151	51	51	
Need 2: Monitor arroyo toad breeding populations.											
2	21	Develop a comprehensive arroyo toad monitoring protocol	1	USFWS*	2	2	0	0	0	0	
				BRD	2	2	0	0	0	0	
2	22	Conduct bi-yearly monitoring of adult populations	Continuous	CDFG*	120	10	10	10	10	10	10
				USFS	600	50	50	50	50	50	50
2	23	Assess the results of population monitoring and modify management direction as necessary	Continuous	CDFG*	12	1	1	1	1	1	1
				USFS	120	10	10	10	10	10	10
Need 2 Subtotal Cost:					856	75	71	71	71	71	
Need 3: Identify and secure additional populations and suitable habitat throughout the range of the arroyo toad.											
2	31	Develop an arroyo toad survey protocol	1	USFWS*	2	2	0	0	0	0	
				CDFG	1	1	0	0	0	0	
2	3211	Survey the main Salinas River upstream from King City for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3212	Survey the San Antonio River for suitable habitat and the presence/absence of arroyo toads	1	FHLMR*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1,000)					ANNUAL COSTS FY 2004 - 2010
						FY 1990	FY 2000	FY 2010	FY 2002	FY 2003	
2	3213	Survey the Nacimiento River for suitable habitat and the presence/absence of arroyo toads	1	FHLMR*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3221	Survey the main Cuyama River above Twitchell Reservoir for suitable habitat and the presence/absence of arroyo toads	1	CDFG*	2	2	0	0	0	0	
				USFS	20	20	0	0	0	0	
2	3222	Survey Husina Creek above Twitchell Reservoir for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3231	Survey Cachuma Creek for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3232	Survey Santa Cruz Creek for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3233	Survey Horse Canyon for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3234	Survey Radrock Canyon for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3241	Survey Elizabeth Creek upstream from Castaic Lake for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3242	Survey San Francisco Canyon drainages for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3243	Survey Bouquet Canyon drainages for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3244	Survey Mint Canyon drainages for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1 000)					ANNUAL COSTS FY 2004 - 2010
						FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	
2	3.2.5.1	Survey San Jacinto River upstream from Hemet for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.5.2	Survey Baughman Creek for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.6.1	Survey Arroyo Trabuco for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.6.2	Survey Cañada Chiquita for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.6.3	Survey Cañada Gobernadora for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.7.1	Survey Fremont Canyon for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.7.2	Survey Black Star Canyon for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.7.3	Survey Baker Canyon for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.7.4	Survey Silverado Canyon for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.8	Survey Temacula Creek above Vail Lake for suitable habitat and the presence/absence of arroyo toads	1	USFS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.9	Survey the San Luis Rey River basin for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1,000)					ANNUAL COSTS FY 2004 - 2010
						FY 1998	FY 2000	FY 2001	FY 2002	FY 2003	
2	3.2.10	Survey the San Diego River basin for suitable habitat and the presence/absence of arroyo toads	1	USFWS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.11	Survey the San Diego River basin for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.12	Survey the Sweetwater River basin for suitable habitat and the presence/absence of arroyo toads	1	USFWS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.13	Survey the Otay River basin for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.14	Survey the Cottonwood Creek drainage basin for suitable habitat and the presence/absence of arroyo toads	1	USFWS*	20	20	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.15	Survey the San Felipe Creek basin for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.16	Survey Bonito Springs and Coyote Creek area for suitable habitat and the presence/absence of arroyo toads	1	CDPR*	2	2	0	0	0	0	
				CDFG	2	2	0	0	0	0	
2	3.2.17	Survey the Vallecito Creek basin for suitable habitat and the presence/absence of arroyo toads	1	CDFG	2	2	0	0	0	0	
2	3.2.18	Survey the Pinto Wash basin for suitable habitat and the presence/absence of arroyo toads	1	BLMP*	2	2	0	0	0	0	
				CDFG	2	2	0	0	0	0	
3	3.3	Identify and implement management actions necessary for securing additional populations of arroyo toads	2	USFWS*	4	2	2	0	0	0	
				CDFG	4	2	2	0	0	0	
Need 3 Subtotal Cost:					501	497	4	0	0	0	

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST THROUGH FY 2010	COST ESTIMATES (\$1,000)					ANNUAL COSTS FY 2004 - 2010
						FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	
Need 4: Conduct research to determine ecology and threats.											
2	4.1	Determine and quantify differences in the life history and ecology of the arroyo toad relative to latitude and elevation.	3	CDFG	25	10	10	5	0	0	
				BRD	25	10	10	5	0	0	
2	4.2	Quantify the ecological parameters, both abiotic and biotic, for arroyo toad presence within drainages.	1	CDFG*	5	0	5	0	0	0	
				BRD	5	0	5	0	0	0	
3	4.3	Experiment with removing exotic aquatic species from arroyo toad habitats.	3	USFS, CDFG	90	30	30	30	0	0	
3	4.4	Determine the best types stream crossings and road barriers.	1	USFS, CDFG	30	30	0	0	0	0	
3	4.5	Determine if arroyo toads are moving between drainages.	3	CDFG	25	10	10	5	0	0	
				BRD	25	10	10	5	0	0	
3	4.6	Assess impacts of different grazing regimes on arroyo toads.	5	USFS	50	10	10	10	10	10	
3	4.7	Assess impacts of recreational activities on toads.	3	USFS, CDFG	30	10	10	10	0	0	
3	4.8	Collect and evaluate tissue samples to determine genetic differences and similarities within and among populations.	3	BRD*	27	15	10	2	0	0	
				CDFG	27	15	10	2	0	0	
Need 4 Subtotal Cost:					364	150	120	74	10	10	
Need 5: Develop information and education programs.											
3	5.1	Develop educational brochures and make them available to agencies.	ongoing	USFWS, CDFG, USFS	16	5	1	1	1	1	1
3	5.2	Provide educational programs for visitors to arroyo toad habitats.	ongoing	USFS, CDPR	120	10	10	10	10	10	10
Need 5 Subtotal Cost:					136	15	11	11	11	11	
TOTAL COST					2,713	888	357	307	143	143	125

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END

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